Project

VALIDATION REPORT – Q1

Iceberg Number Density

Reference: MYO-WP14-SIW-DMI-ARC-SEAICE_BERG-OBS-VALIDATION_Q1

Project N°: FP7-SPACE-2007-1	**Work programme topic:** SPA.2007.1.1.01 - development of upgraded capabilities for existing GMES fast-track services and related (pre)operational services
Start Date of project: 2009/04/01	**Duration**: 36 Months

WP leader: met.no	**Issue:** 1.0
Contributors: Jørgen Buus-Hinkler	
Date: March 2011	**30 March 2011**
Dissemination level:CO	

CHANGE RECORD

Issue	Date	§	Description of Change	Author	Checked By
1.0	2011-03-29		New	Jørgen Buus-Hinkler	

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GLOSSARY AND ABBREVIATIONS

AMSR	Advanced Microwave Scanning Radiometer
NetCDF	Network Common Data Form
PUM	Product User Manual
SAR	Synthetic Aperture Radar
SIW	Sea Ice and Wind

I.1 Product introduction

The iceberg number density product is based on satellite data from SAR (Radarsat, and in the near future also Envisat). The output is iceberg number density given as number of icebergs sampled in grid cells each covering 10 x 10 km. Each file produced is a netCDF file including a grid which more or less covers the entire Greenland Waters, however the spatial coverage of each SAR scene is much smaller – about 500 x 500 km (see Figure 1).

The measured SAR signal (backscatter coefficient) is proportional to the surface roughness, meaning that for iceberg detection we use SAR images (at 100 m spatial resolution) to describe the roughness of the sea surface (icebergs are assumed to be particularly rugged objects). The DMI iceberg detection algorithm utilizes a Constant False Alarm Rate (CFAR) concept (see Gill, 2001 and e.g. http://www.ll.mit.edu/HPECchallenge/cfar.html). Basically this means that if a given pixel (backscatter value) deviates significantly from the background noise calculated for nearby pixels, this pixel will be classified as an "iceberg-pixel".

Virtually, the CFAR algorithm detects objects (icebergs) that are significantly more rugged than the surrounding surface, and thus, icebergs cannot be detected with sufficient accuracy within ice infested waters. Therefore, only icebergs detected in open water are included in the final product. In order to exclude icebergs detected within sea-ice, passive microwave (Advanced Microwave Scanning Radiometer [AMSR]) satellite data is used to obtain the approximate sea ice concentration at the iceberg locations.

The product is transmitted from DMI to the SIW-TAC Dissemination Unit at met.no in CF-1.4 compliant NetCDF format. The netCDF file is checked against the CF-Convention compliance checker for NetCDF format developed at the Hadley Centre for Climate Prediction and Research, UK Met Office by Rosalyn Hatcher. The checker can be found at http://puma.nerc.ac.uk/cgi-bin/cf-checker.pl

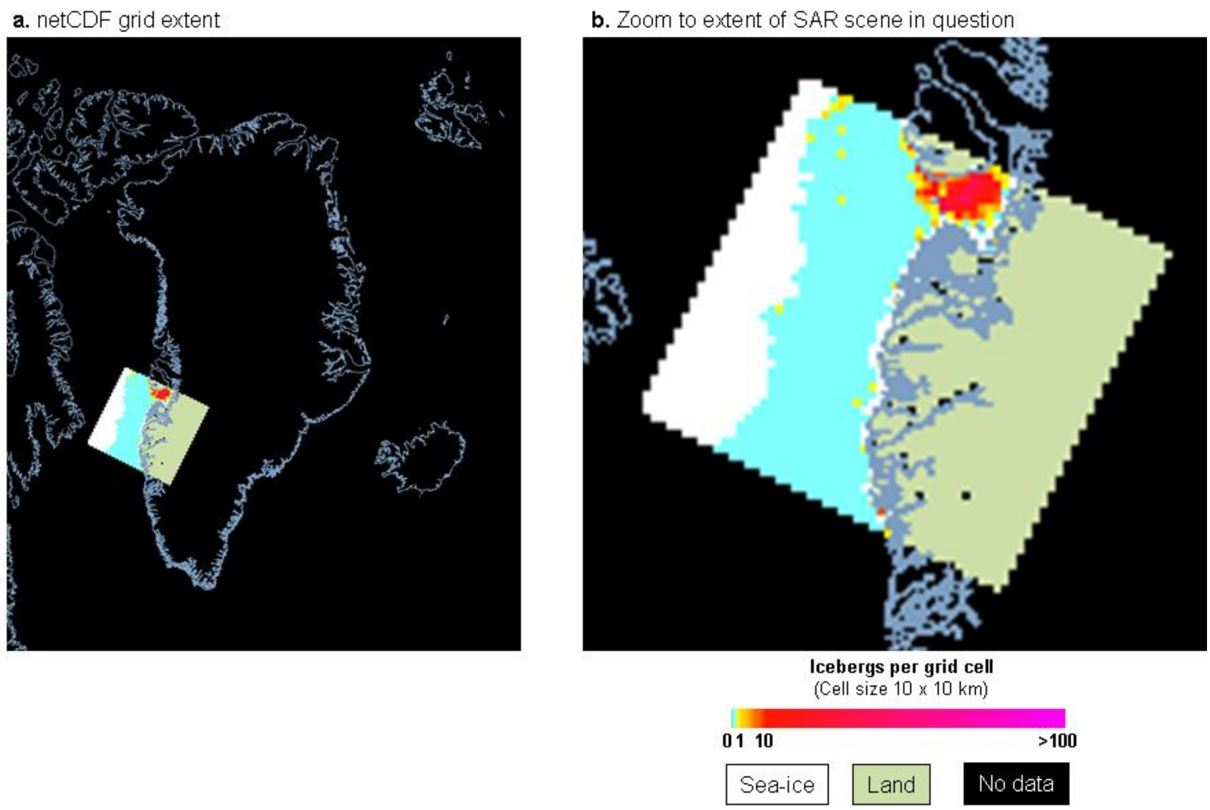

Figure 1. *Illustrated iceberg number density.*

I.2 Validation

Due to different forms of noise affecting the SAR signal, errors (false icebergs) may arise in the CFAR iceberg product. However, due to lack of (and difficulties in getting) ground truth data, true validation of iceberg number density is a challenging if not impossible task.

Thus, to describe whether the results are likely to be within a realistic range we have used about 10 years of SAR data from the DMI archive to generate iceberg statistics for the Greenland Waters. Each product will then be compared to these statistical data. For each valid 10x10 km grid cell over the Greenland Waters, percentiles (P84 and P97) of iceberg number density have been derived. The percentiles have been derived using a running seasonal analysis (see Figure 2). Note that valid grid cells represent satellite overpasses occurring only over open water.

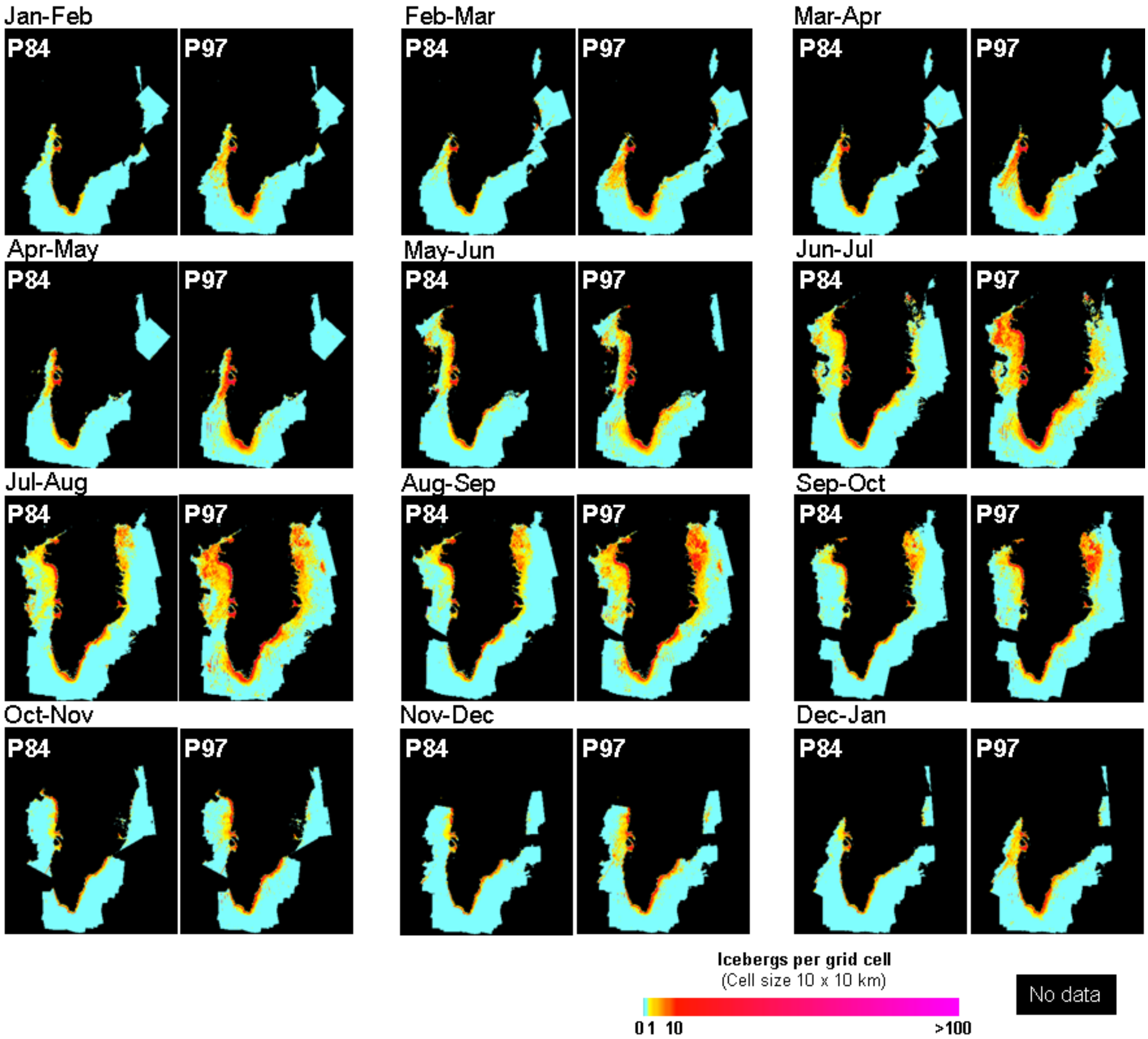

Figure 2. *Seasonal percentiles (P84 and P97) of iceberg number density.*

Figure 2 shows the seasonal variation in iceberg number density in individual 10 x 10 km grid cells around Greenland under: rather heavy (P84), and extreme (P97) conditions – based on Radarsat SAR recorded over more than 10 years (2000-2010) . Assuming a normal distribution P84 approximately corresponds to the mean + 1 std. dev. and P97 to the mean + 2 std. dev. Although iceberg number density is not normally distributed we have used these percentiles to divide our observations into three categories of uncertainty: 1. "normal" (< P84), 2. "critical" (]P84:P97]), 3. "extreme" (]P97:P100]). Note that uncertainty data will (of course) only be available in areas with valid statistics (non-black areas in figure 2).

Figure 3 shows two examples of iceberg number densities including category of uncertainty (the data was inferred from Radarsat-SAR on January 22nd, 2011 and March 4th, respectively). The January 22nd data has virtually no potential errors, whereas the data from March 4th has quite a lot of potential errors. These errors are most likely due to extremely low backscatter to the east of the sea-ice present along the East Greenland coast on March 4th. The low backscatter results in very low image dynamics, which is not adequate for iceberg detection.

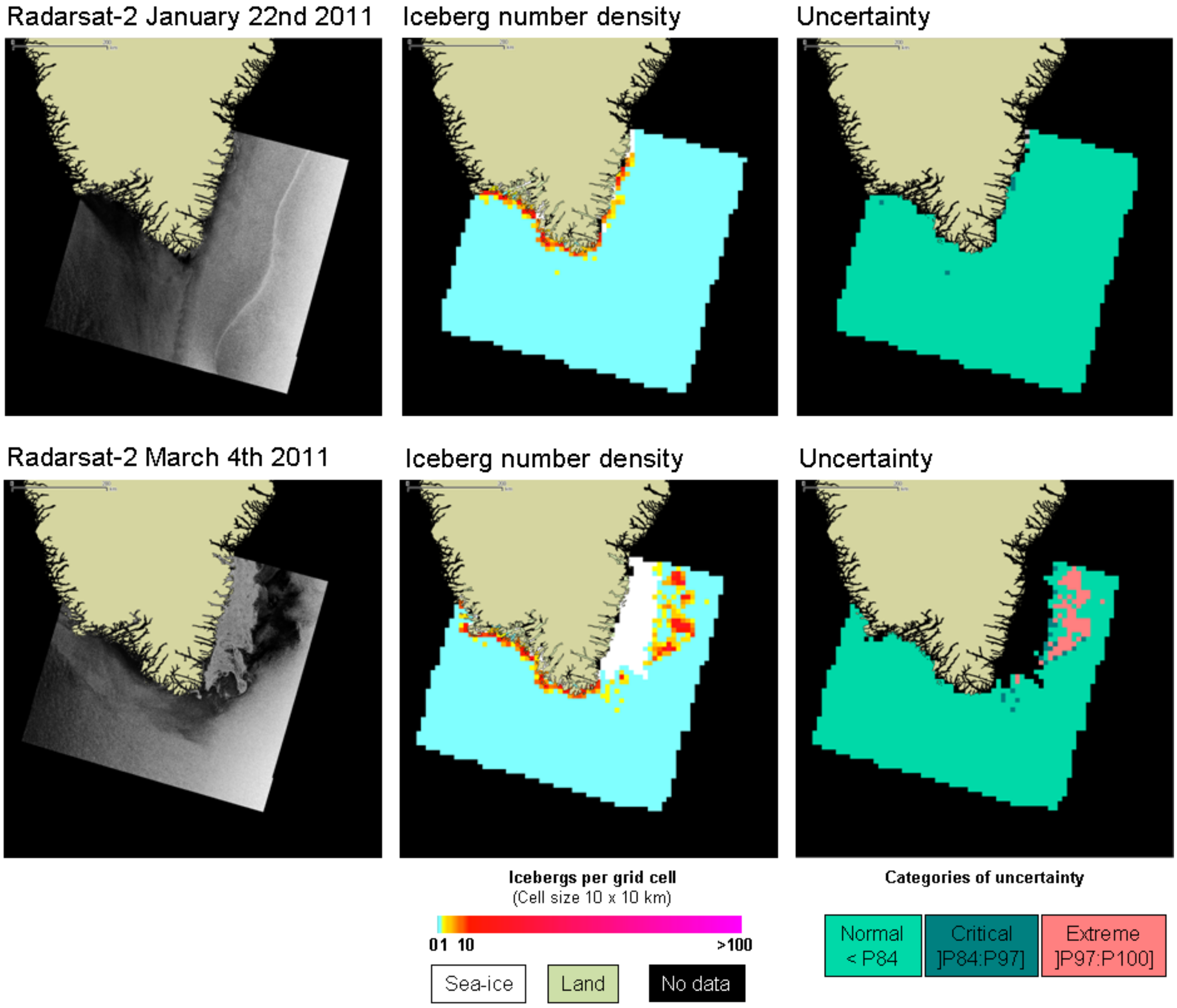

Figure 3. *Examples of iceberg number density data inferred from satellite borne SAR including categories of uncertainty. Top: illustration of data with virtually no potential errors. Bottom: illustration of data with a larger amount of potential errors.*

I.3 Further development

In future versions of the iceberg number density product, an additional layer including the three categories of uncertainty will be added to the net-CDF files. This has however still not been operationalized in the net-CDF production line, but is expected to be in the *near* future.

References

Gill R. S., (2001). "Sea Ice Edge and Icebergs Detection using routine operations". Canadian J. REMOTE SENSING, special issue on Sea Ice and Icebergs, ivol. 27, no. 5, pp 411 – 432.