SEA ICE IMAGE DATASET FOR EDUCATION (SIDE)

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ABSTRACT:

The use of remote sensing is necessary for monitor wide sea ice areas. However, since different scale sea ices often show similar geometrical shapes and patterns like fractal, it is not easy for unskilled people to interpret the conditions of sea ice from aerial photos or satellite images. Moreover, the feature and name of sea ice changes as it grows. The sea ice types are defined in details. It is not easy for the beginners to identify each sea ice types at their field survey. In order to allow beginners to understand about the sea ice types and how the sea ice looks in different scales of remote sensing images, the authors have developed a sea ice image dataset called SIDE(Sea ice Image Data set for Education). SIDE allows users to understand various kinds of sea ice type with categorized descriptions and many color images.

1. INTRODUCTION

Satellite images are daily used for sea ice monitoring on a global basis. ESA is operating the ICEMON service system(2006) for monitoring sea ice in the polar regions. The National Ice center(NIC, 2006) of USA is a multi-agency operational ice center operated by NOAA, US Navy and other organizations to provide various ice services. In Japan, the Japan Coast Guard is operating the Ice Information Center(IIC, 2006) every winter to disseminate sea ice distribution information of the Okhotsk Sea. In these organizations, various information on sea ice are provided to users to make them understand more about sea ice.

However, there are various kinds of sea ice types (see Figure 1), and their conditions/sizes/locations change from time to time. Different scale sea ices often show similar geometrical shapes and patterns like fractal. Various type and size of sea ice are often mixed and distributed in same sea ice area. Thus sea ice information interpretation from aerial photos or satellite images is not easy. Without certain knowledge on sea ice and resolution difference of remotely sensed data, users are likely to misread the sea ice information from sea ice images taken by airplanes or satellites.

In order to allow beginners to understand about the sea ice types and how the sea ice looks in different scales of remote sensing images, the authors have developed a sea ice image data set called SIDE(Sea ice Image Data set for Education). The outline and the initial result of SIDE is described in this paper.

2. DEVELOPMENT CONCEPTS OF SIDE

The development concepts of SIDE are as follows.

2.1 Target users

The target users of SIDE are beginners on sea ice and remote sensing who are interested in using remote sensing data for studying/ monitoring sea ice.

2.2 Sea ice type definition

The definition of sea ice types were conformed to World Meteorological Organization (WMO) definition (1970).

2.3 Structure

SIDE mainly consists of sea ice classified table, sea ice development chart, and sea ice images. All of the information are in HTML format, mutually hyper linked, and accessible via internet.

(a) Pancake ice

(b) Nilas

(c)Young ice

(d) First-year-ice

Figure 1. Examples of various types of sea ice

DATA USED IN THIS STUDY

In this study, various sea ice images consist of on site photos, aerial images, and satellite images of the Okhotsk Sea were used for making the SIDE dataset. Most of the satellite images were from optical sensors. Table 1 shows the main data sources used for the initial dataset development.

Table 1. Main data sources used for SIDE

Date source	Observation date	Reolution
On site photo	Feb. 23, 2000	
	Mar. 2-4, 2004	
	Mar. 1-4, 2005	
Aerial photo	Mar. 6, 2003	10～12cm
IKONOS	Mar. 10, 2000	1m
Landsat / ETM	Mar. 6, 2003 etc.	15m
MOS-1 / MESSR	Feb. 22, 1995	50m
Terra / MODIS	Feb. 21, 2003 etc	250m
Radarsat/SAR	Feb. 21, 1998	30m
DMSP SSM/I	Feb. 23, 2004	25km

4. DEVELOPMENT PROCEDURE

The following procedure was performed to develop the sea ice image dataset SIDE.

4.1 Sea ice type classification

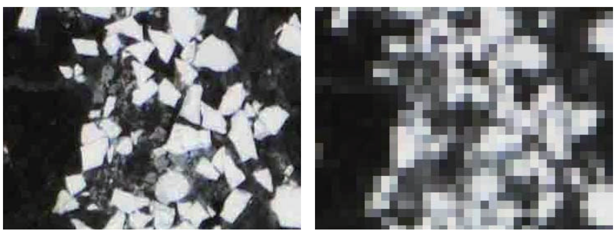
Firstly, the sea ice types were classified with (a)development, (b)formation and (c)surface features of sea ice as defined by WMO and put on a table.

4.2 Classification of sea ice images

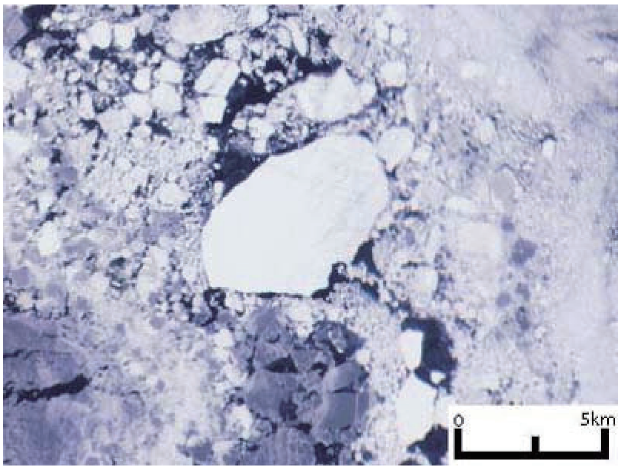
As shown on Table 1, various types of sea ice images were collected and classified by sea ice types and data source.

4.3 Image processing

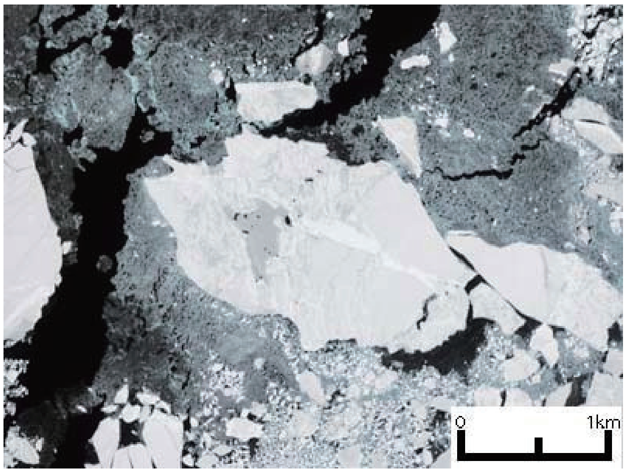
The appearance of sea ice in aerial images and satellite images dramatically changes according to the spatial resolution of sensors and display scale of the images. A set of low resolution images were produced by averaging the higher resolution images to show how the outlook of sea ice changes with the resolution reduction of images. Figure 2 shows such an example. To show the sensor difference, different sensor images were collected for same type of sea ice as shown on Figure 3.



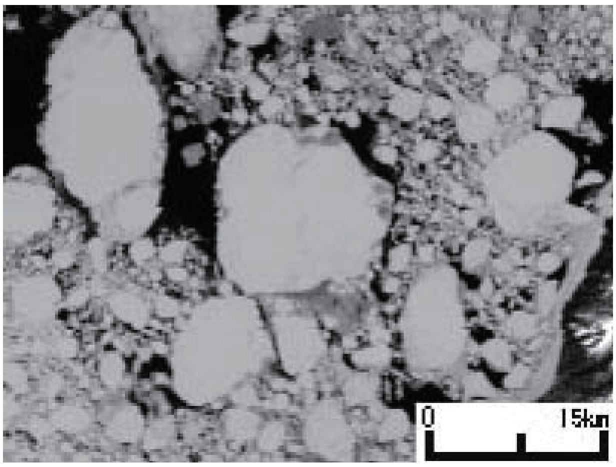
(a) Original image(IFOV:1m) (b) Averaged image(IFOV:10m)
Figure 2. Comparison of sea ice image in different resolution.
(Data source: IKONOS, (C) JSI)



(a) IKONOS image (© JSI)



(b) MESSR image (JAXA)



(c)MODIS image (NASA)

Figure 3.vast floe in different sensor images

4.4 Structuring of the dataset

Figure 4 shows the structure of SIDE .The dataset is consisted of the following five sections.

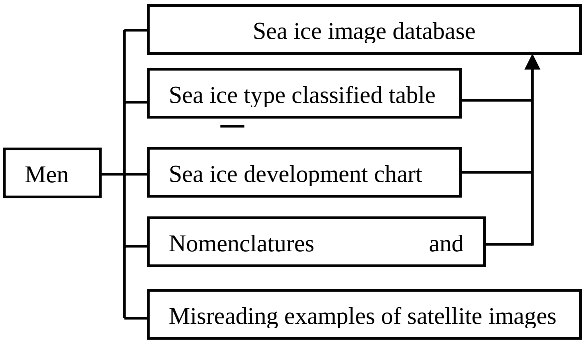


Figure 4. Structure of SIDE

4.4.1 Sea ice type classified table

The sea ice types are classified by three subjects which are "development", "forms", and "surface features". Table 2 shows a part of the classified table according to the forms of sea ice.

Table 2. Example of sea ice type classified by forms.

Classification by forms		
Type	Subtype	explanation
Floe		Any relatively flat piece of sea ice 20 m or more across. Floes are subdivided according to horizontal extent as follows.
	Small floe	20-100 m across.
	Medium floe	100-500 m across.
	Big floe	500-2000 m across.
	Vast floe	2-10km across.
	Giant floe	Over 10 km across.

4.4.2 Sea ice image database

Various sea ice images were collected including on site photo, aerial image, and satellite images. Figure 5 shows on site photos examples of grease ice.

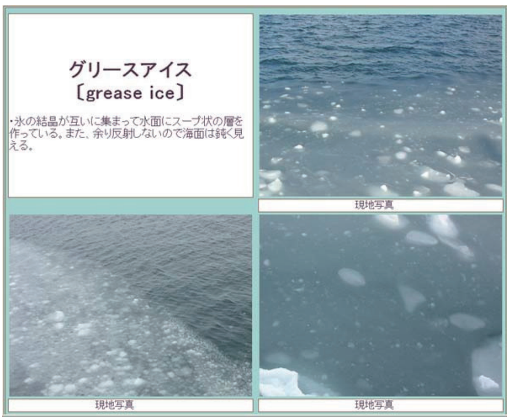


Figure 5. Image galley of grease ice

4.4.3 Sea ice development chart

To help users to understand the sea ice development process, sea ice development chart was produced as shown on Figure 6. Each sea ice category names are hyper linked to actual sea ice images. For an example, if the user clicks "grease ice", Figure 5 will pop up on the screen.

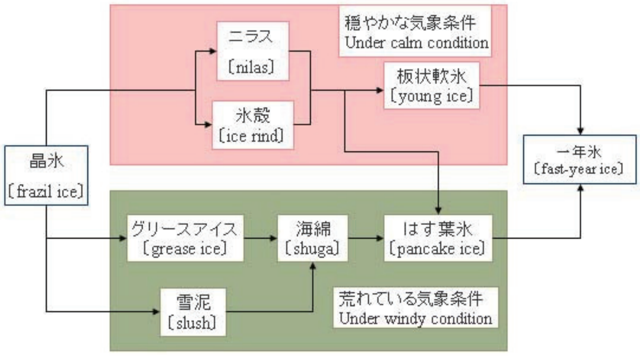


Figure 6. Sea ice development chart

4.4.4 Misreading examples of satellite images

As described in the introduction, the scale difference of satellite images is quite difficult to recognize. In this section, examples of satellite images that may cause misreading of sea ice information are presented.

Figure 7 shows sea ice images of IKONOS(IFOV=1m) and MOS-1/MESSR(IFOV=50m). The ice plate in the center of both images look similar, but their sizes are very different from each other. Without checking the scale of remote sensing images, users are likely to misread the information from those images.

Figure 8 shows IKONOS images in different resolution (IFOV). (a) is the original IKONOS image with IFOV=1m, and (b) is 20pixel x 20pixel averaged IKONOS image which corresponds to IFOV=20m. In the original image (a), thin ice is clearly recognized in the center of the image. However, in the averaged image (b), the area looks as open water. Also, ice crack in a medium floe which can clearly be seen in the image (a) can not be recognized in the image (b). These images clearly show how sea ice information are reduced as the resolution goes down.

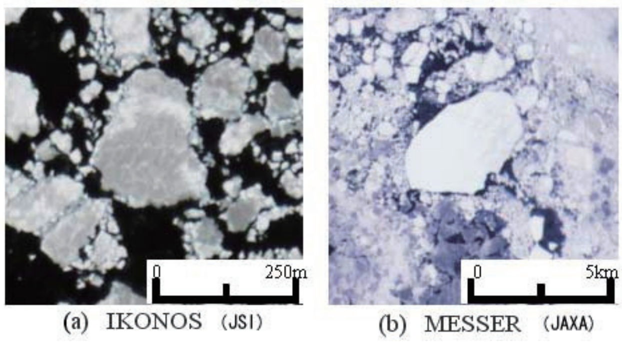
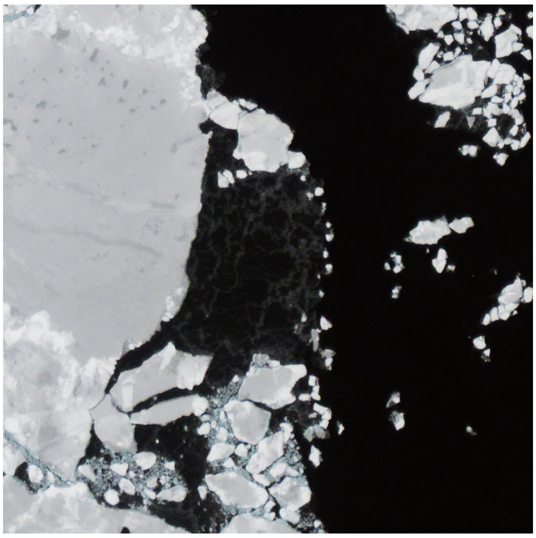
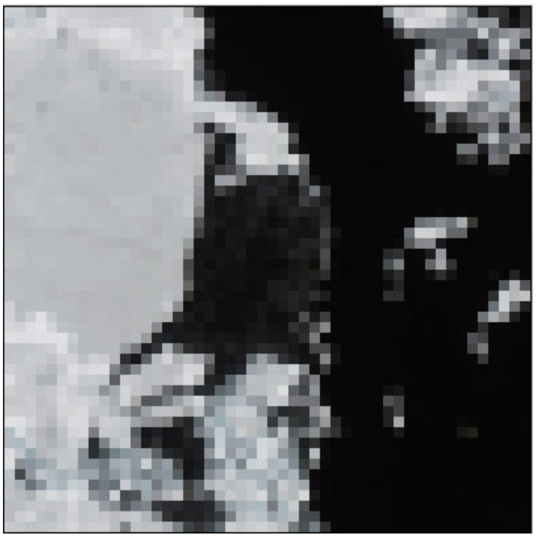


Figure 7. Scale difference of satellite images.



(a) IFOV=1m



(b) IFOV=20m

Figure 8. IFOV difference in an IKONOS image (© JSI)

Table 3. Examples of nomenclatures and definitions of sea ice

[Development] **New ice:** A general term for recently formed ice which includes frazil ice, grease ice, slush and shuga. These types of ice are composed of ice crystals which are only weakly frozen together (if at all) and have a definite form only while they are afloat. **Frazil ice**: Fine spicules or plates of ice, suspended in water. **Grease ice**: A later stage of freezing than *frazil ice* when the crystals have coagulated to form a soupy layer on the surface. Grease ice reflects little light, giving the sea a matt appearance. **Slush**: Snow which is saturated and mixed with water on land or ice surfaces, or as a viscous floating mass in water after a heavy snowfall.

4.4.5 Nomenclatures and definitions

The nomenclatures and definitions of sea ice types are described in this section following the definition of WMO. Table 3 shows an example of the description. Most of the sea ice type names in this section are also hyper linked to the sea ice image database. So it is easy for the users to recognize definitions and outlook of each sea ice type.

5. CONCLUSIONS

The authors have developed a sea ice image dataset SIDE. The SIDE helps beginners to understand about the names/definitions of various sea ice types and how each sea ice type looks in various kinds of images such as on site photos, aerial images and satellite images. Especially, various kinds of satellite images of sea ice are collected and displayed in systematic manner which allow users to recognize the scale difference and resolution difference of satellite images for interpreting sea ice information from them.

The initial version of SIDE is now accessible at the following site. http://www.yc.ycc.u-tokai.ac.jp/ns/cholab/seaice/top.htm

SIDE needs more to be improved. The authors are planning to expand and revise it from time to time. One of the plans is to add kinds of interactive exercises to allow users to check their understanding on the sea ice types. The authors are pleased to have comments, suggestions, and contributions from the scientific community.

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