VARIATION OF LANDFAST SEA ICE IN TERRA NOVA BAY, EAST ANTARCTICA, OBSERVED BY SAR INTERFEROMETRY

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1. INTRODUCTION

Landfast ice is a type of sea ice adjacent to the coast and immobile for a certain period of time. It is important to analyze the temporal and spatial variation of landfact ice because it has significant influences on marine ecosystem and the safe operation of icebreaker vessels. However, it has been a difficult task for both remote sensing and *in situ* observation to discriminate landfast ice from other types of sea ice, such as pack ice [1-8]. In this study, we identify landfast ice and its annual variation in Terra Nova Bay (74° 37′ 4"S, 164° 13′ 7"E), East Antarctica, where Jangbogo Antarctic Research Station has recently been constructed in 2014 (Fig.1), by using Interferometric Synthetic Aperture Radar (InSAR) technology.

2. METHODS

We generated 38 interferograms and coherence images (Table 1) having temporal baselines of 1-9 days out of 62 COSMO–SkyMed SAR images over Terra Nova Bay obtained from December 2010 to January 2012. We classified the regions of high coherence into landfast ice while low coherence regions are classified into pack ice or open sea with a help of backscattering images. Variation of areas of the landfast ice, pack ice and total ice were plotted and analyzed with other environmental factors such as air temperature and wind observed at an automatic weather station installed near Jangbogo station.

3. RESULTS AND DISCUSSIONS

Landfast ice maintained relatively high coherence with a temporal baseline of up to 9 days (Fig. 2). Longer temporal baselines have caused losing coherence due to wind-driven erosion or snow accumulation on sea ice surface. Pack ice and open sea completely lost coherence due to large displacement. Pack ice is easily discernable from open sea by observing cracks and ridges developed inside the ice chunk in the backscattering images. No landfast ice was observed during the summer of 2010 from November to March (Fig. 3). Landfast ice began to

appear in March 2011 and the extent reached annual maximum of 170.7 km^2 in July 2011. It was then decreased from October but did not vanish until the end of the observation period in January 2012. Contrary to the summer of 2011, there was no landfast ice-free period in the study area during the summer of 2012, alerting potential logistic problems of icebreaker vessels approaching Jangbogo Antarctic Research Station. Pack ice appeared two months earlier than landfast ice in January 2011 and reached its maximum extent in May 2011. It soon disappeared from July when the study area is almost filled with landfast ice.

Pack ice began to develop when air temperature dropped below the freezing point in January 2011 while there was a two-month lag in the formation of landfast ice. Landfast ice began to melt in November 2011 when air temperature raised above freezing point but lasted more than two month to the end of the study period in January 2012. No meaningful relationship was found between sea ice extent and wind from the dataset.

4. CONCLUSIONS

A series of InSAR images with short baseline was successfully used to identify the landfast ice from pack ice and open sea, and thus to analyze the annual variation of sea ice extent in Terra Nova Bay, East Antarctica. It was found that landfast ice can endure summer melting in the study area. Two-month lag was also found for the landfast ice formation after air temperature rises above freezing point. More InSAR data would be essential to analyze inter-annual behavior of landfast ice.

5. REFERENCES

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Table 1. COSMO–SkyMed InSAR pairs used in this study.

Dates of InSAR pair (yyyy/mm/dd)	Temporal baseline (day(s))	Dates of InSAR pair (yyyy/mm/dd)	Temporal baseline (day(s))
2010/12/01, 2010/12/09	8	2011/06/19, 2011/06/27	8
2010/12/09, 2010/12/10	1	2011/07/05, 2011/07/06	1
2010/12/25, 2010/12/26	1	2011/07/22, 2011/07/29	7
2011/01/02, 2011/01/10	8	2011/08/06, 2011/08/07	1
2011/01/10, 2011/01/18	8	2011/08/22, 2011/08/23	1
2011/01/26, 2011/01/27	1	2011/08/30, 2011/09/07	8
2011/02/11, 2011/02/19	8	2011/09/07, 2011/09/08	1
2011/02/27, 2011/02/28	1	2011/09/15, 2011/09/24	9
2011/03/15, 2011/03/16	1	2011/10/01, 2011/10/09	8
2011/03/23, 2011/03/31	8	2011/10/09, 2011/10/10	1
2011/03/31, 2011/04/01	1	2011/10/25, 2011/10/26	1
2011/04/01, 2011/04/08	7	2011/11/02, 2011/11/10	8
2011/04/08, 2011/04/16	8	2011/11/10, 2011/11/11	1
2011/04/16, 2011/04/24	8	2011/11/18, 2011/11/26	8
2011/05/02, 2011/05/03	1	2011/11/26, 2011/11/27	1
2011/05/18, 2011/05/19	1	2011/12/28, 2011/12/29	1
2011/06/03, 2011/06/04	1	2012/01/05, 2012/01/13	8
2011/06/03, 2011/06/11	8	2012/01/13, 2012/01/14	1
2011/06/19, 2011/06/20	1	2012/01/13, 2012/01/21	8

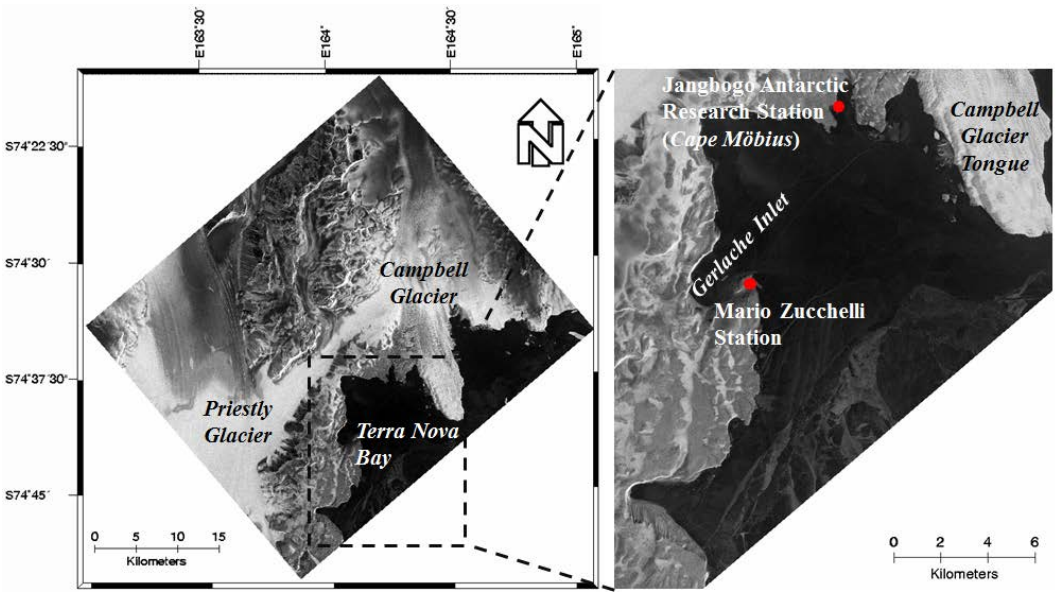

Fig. 1. The study area in Terra Nova Bay, East Antarctica, as seen by a COSMO-SkyMED SAR image obtained on 11 November 2011.

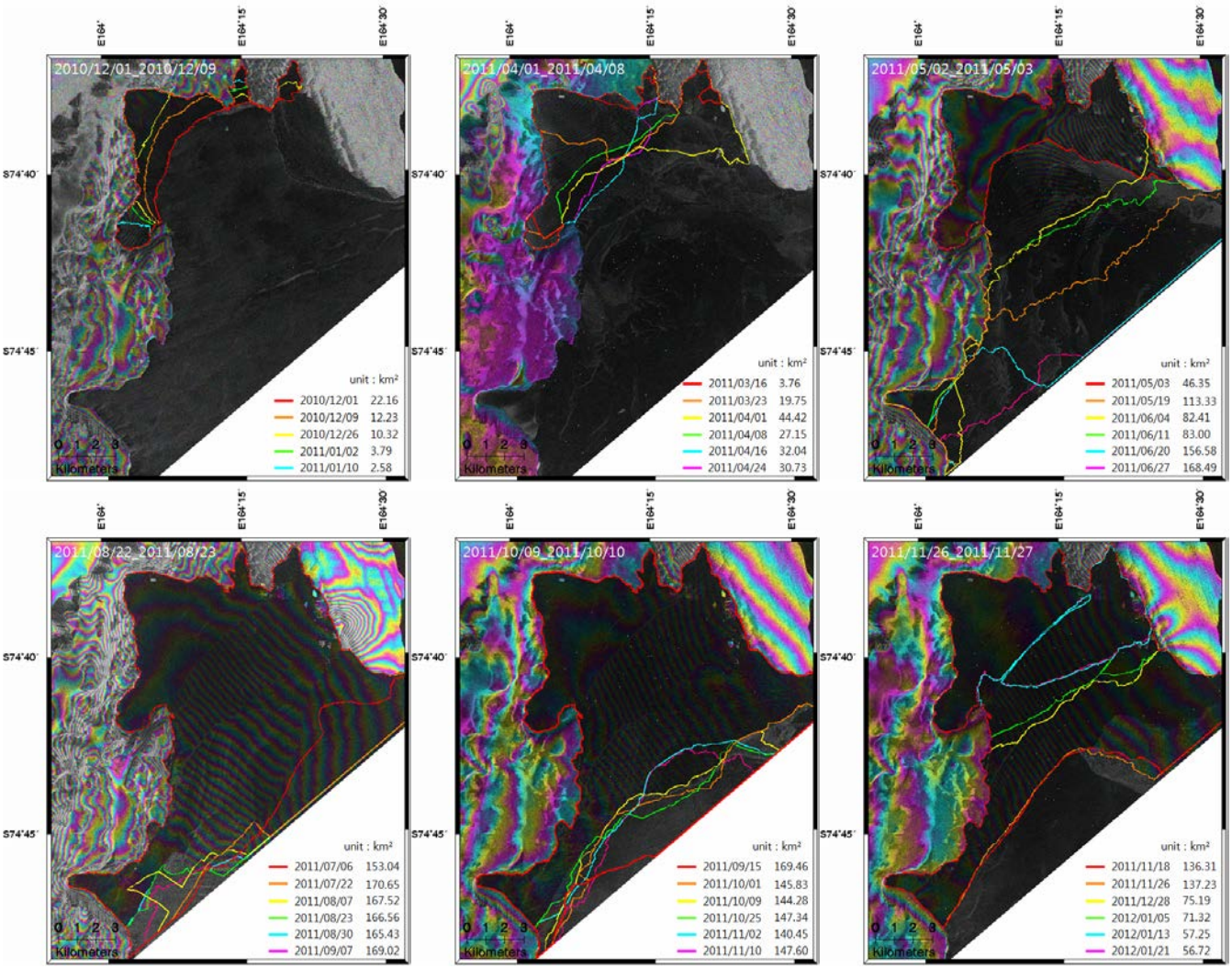

Fig. 2. Temporal variation of the extent of landfast ice in Terra Nova Bay from December 2010 to January 2012 overlaid on the selected SAR interferograms.

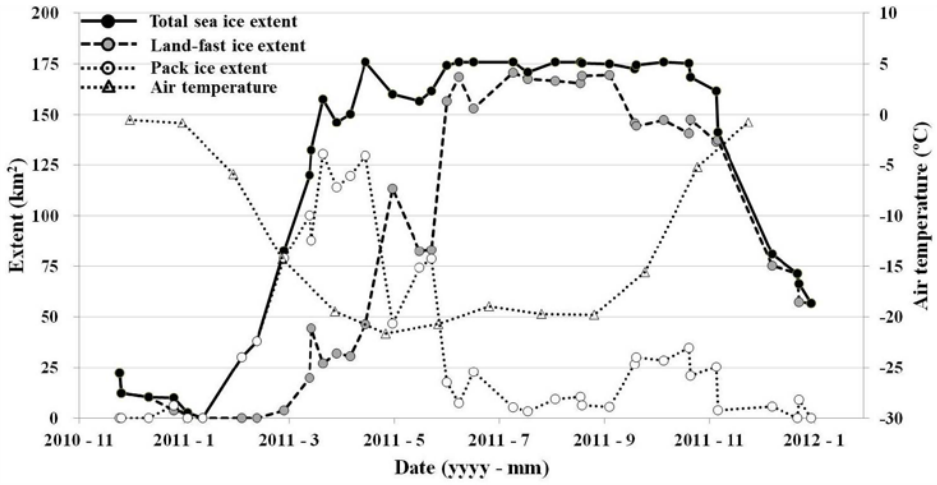

Fig. 3. Temporal variations of the extent of the land–fast sea ice, pack ice and the total ice, and air temperature.