Contributions of ALOS / PALSAR data for Cryospheric Science and Expectations to the next generation L-band SAR Satellites

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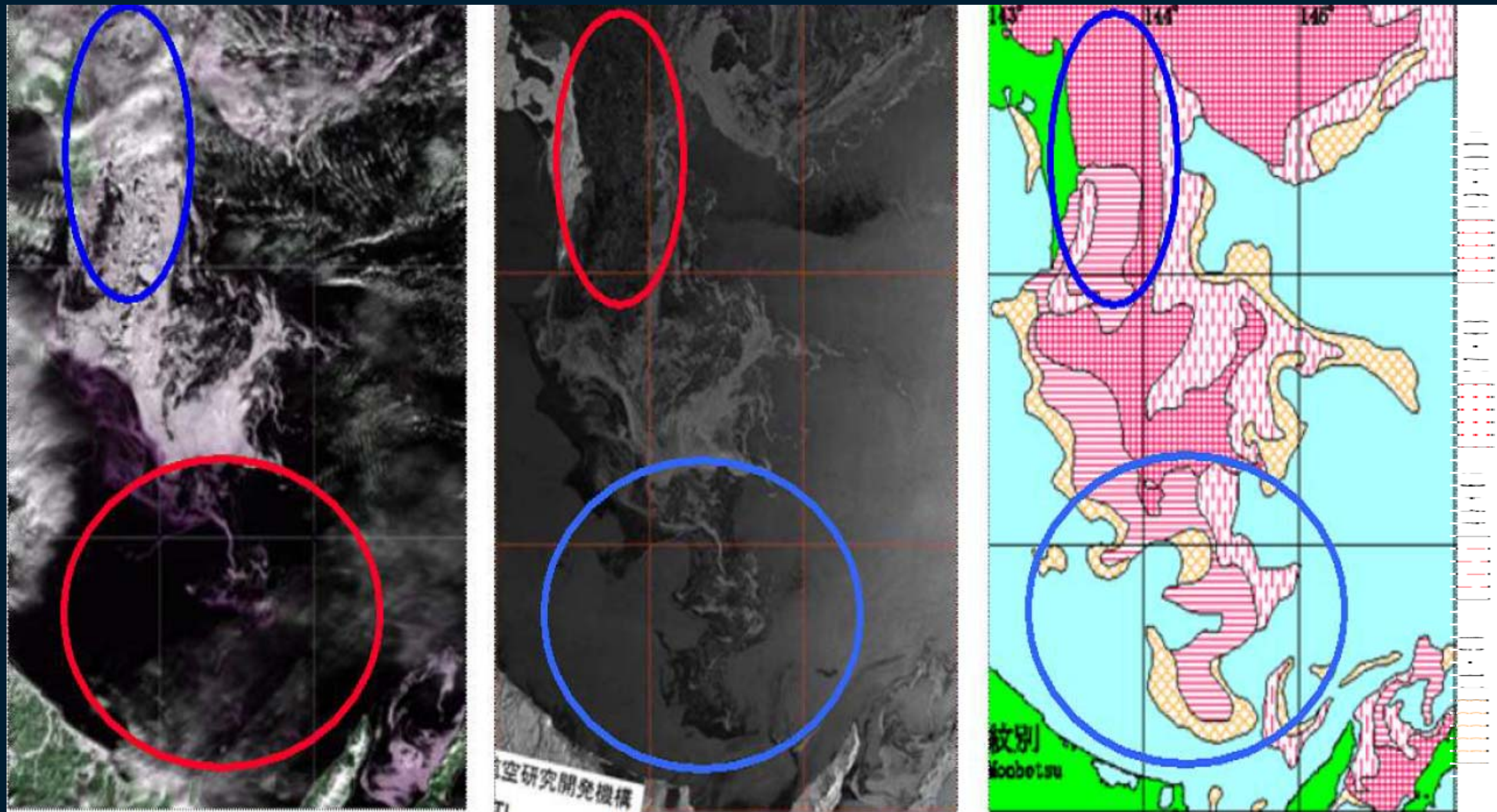
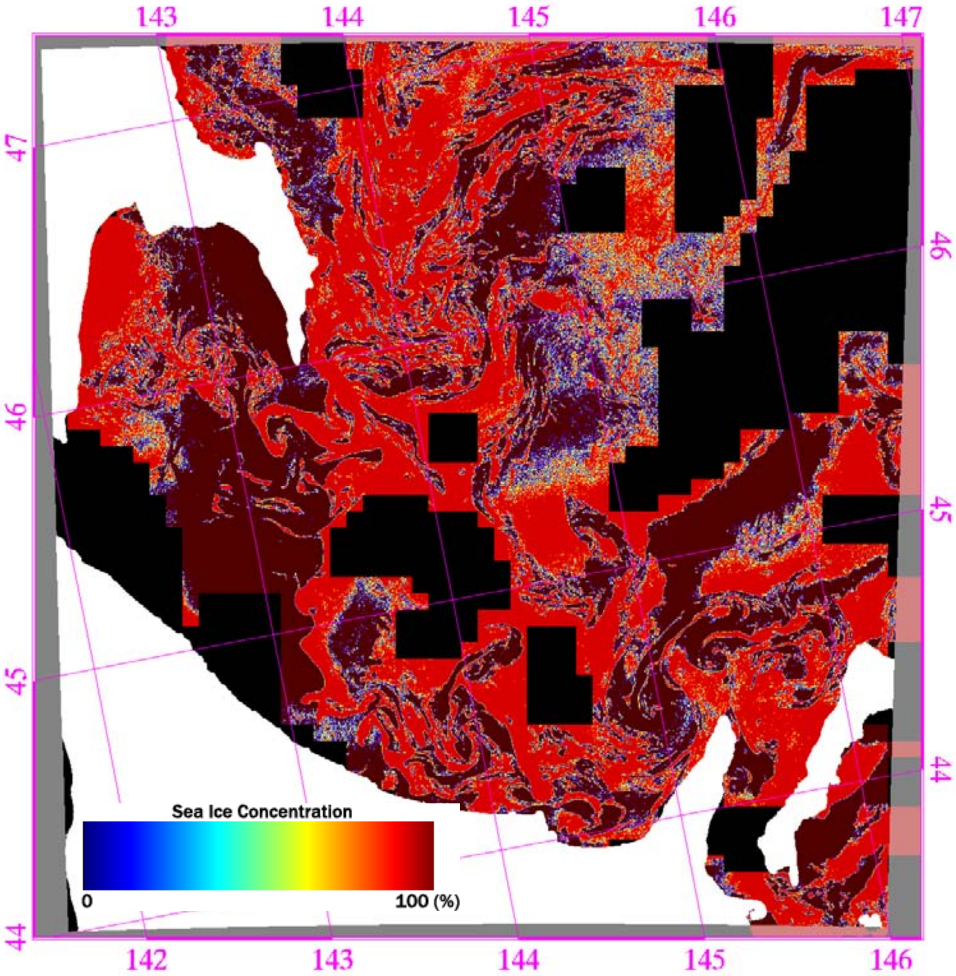


(a)MODIS image (b)SCANSAR image(©JAXA) (c) Sea ice condition chart (JCG)

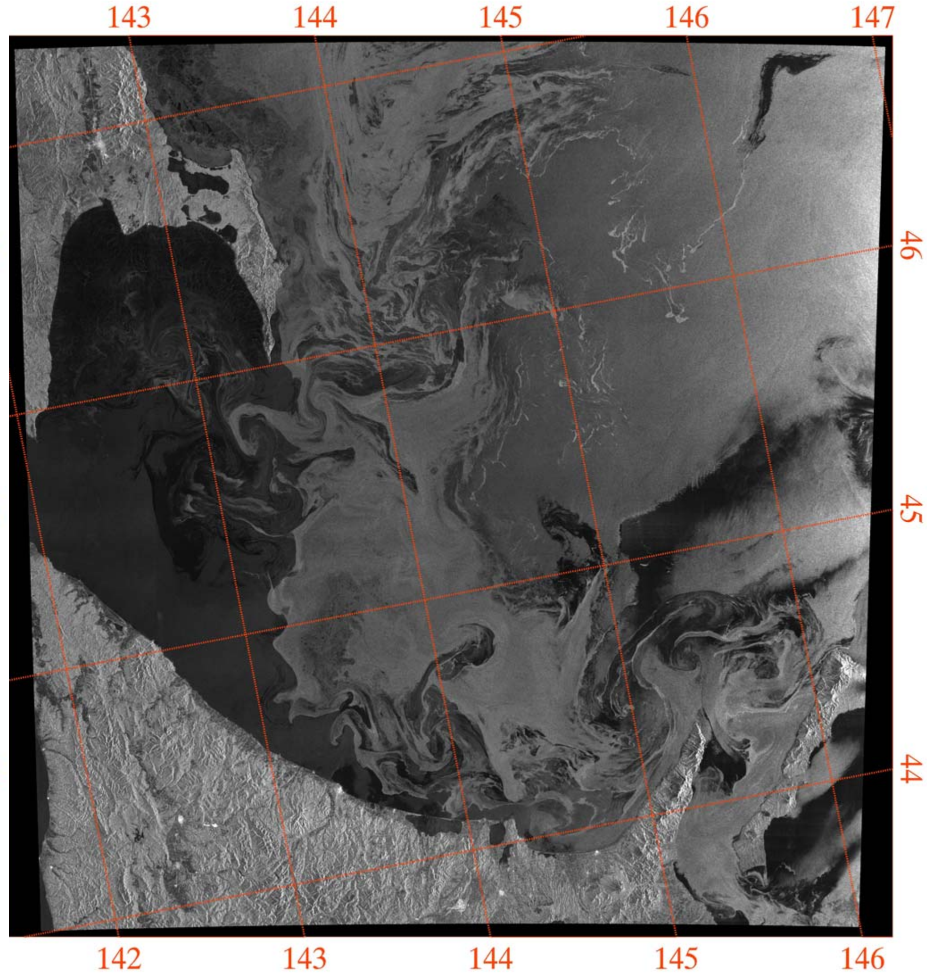
ig.5 Comparison of MODIS and SCANSAR images with Sea ice condition chart (January 31, 2010)

- ALOS / PALSAR data is operationally used by JCG (Japan Coast Guard)
- In blue circles, features of sea ice can be clearly identified, while it seems to be difficult to interpret the sea ice in area by red circles. (Cho, 2009, PI215-1-6)

I. Sea Ice monitoring on Okhotsk Sea



Sea Ice Concentration



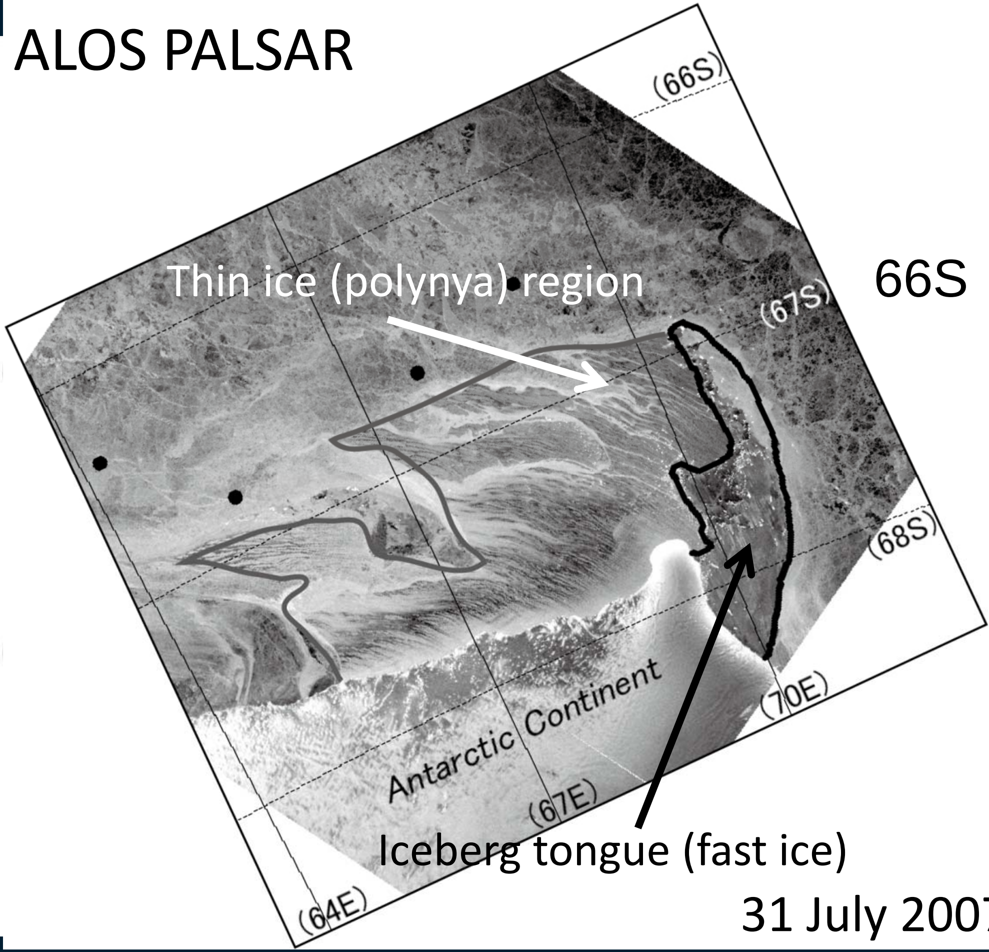
PALSAR ScanSAR Intensity Image

20, February, 2011 ALOS/PALSAR ScanSAR

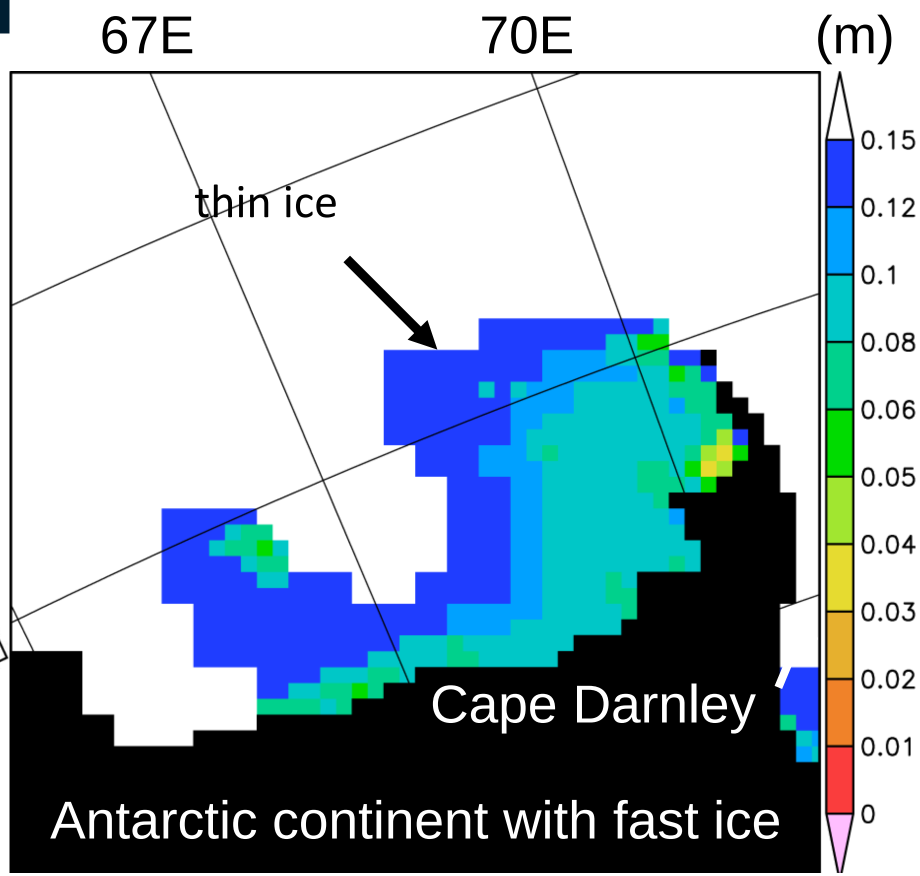
II. Understanding the formation mechanism of Polynya

- Unknown new AABW formation area was found
- PALSAR data is used for validation of microwave radiometer-derived ice thickness

ALOS PALSAR



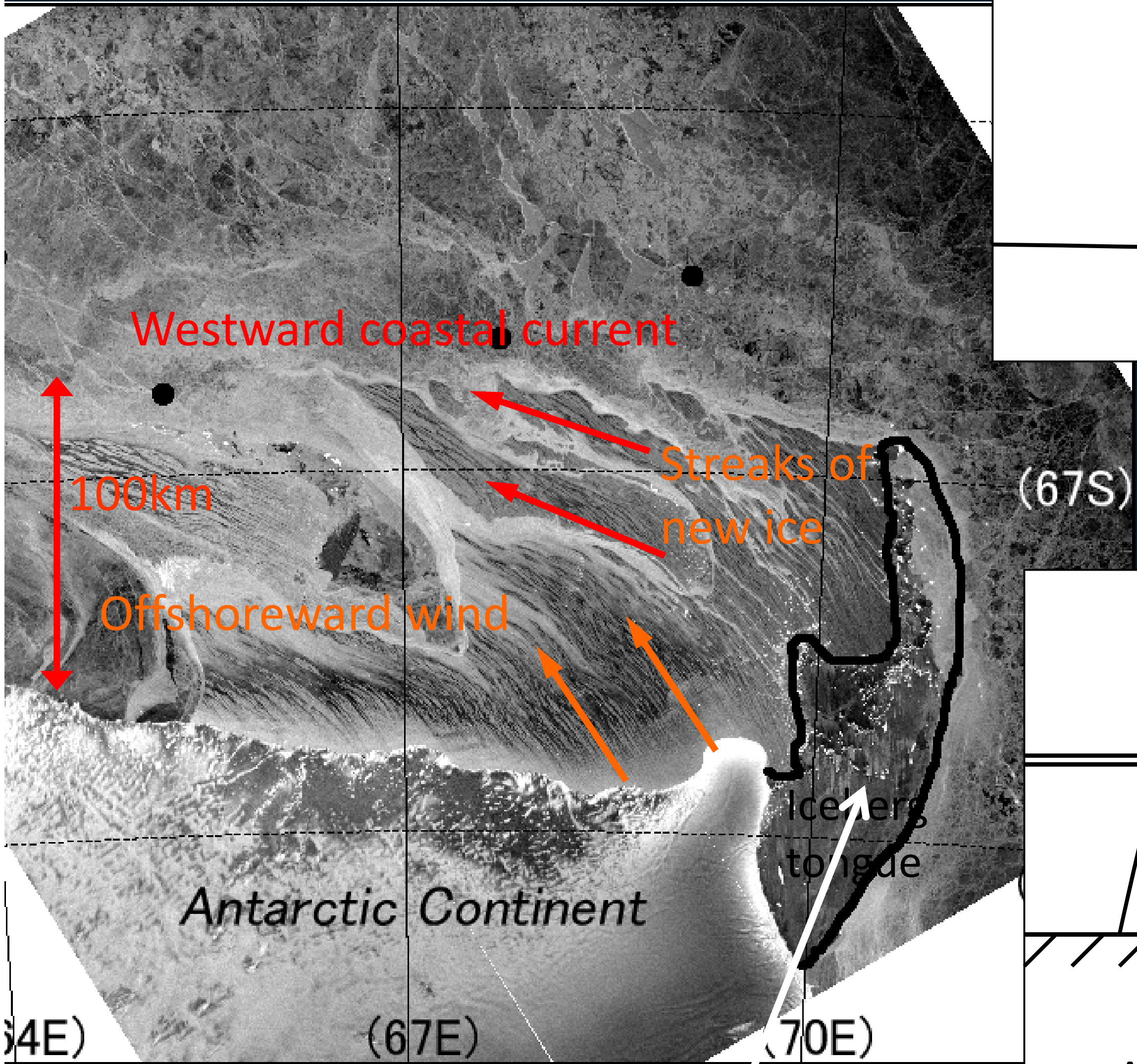
31 July 2007



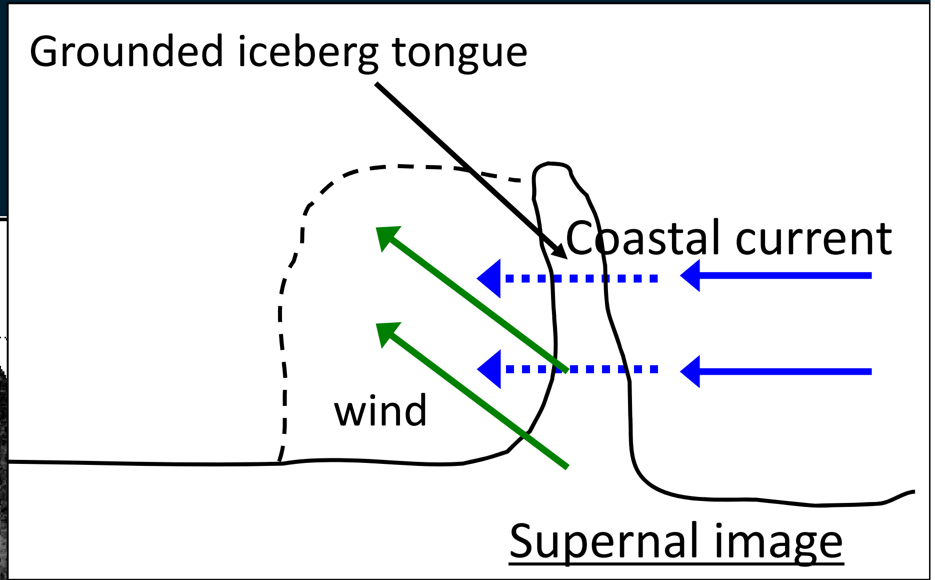
from AMSR thin ice algorithm

(Ohshima, 2009, PI322-1-8)

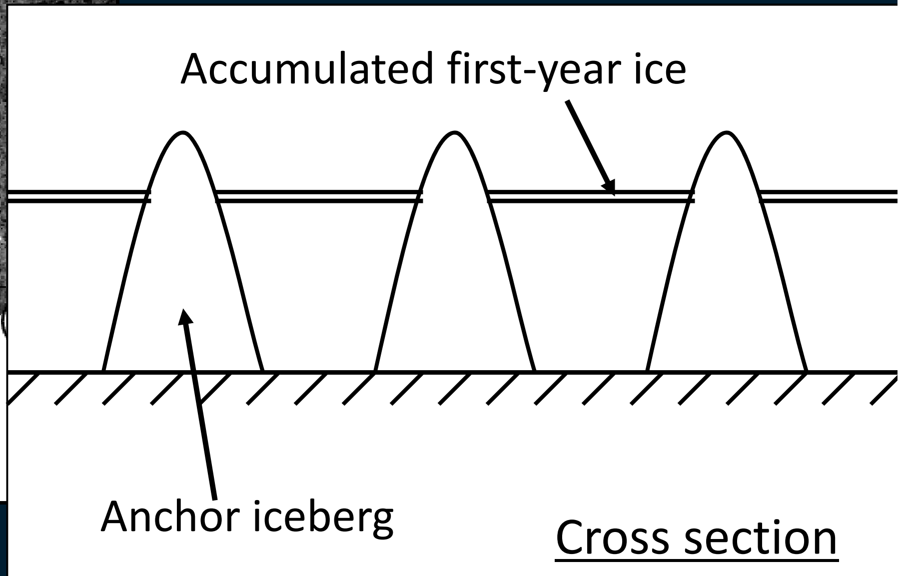
Formation mechanism of Cape Darnley polynya



Iceberg tongue (fast ice)



Filtering effect of Iceberg tongue



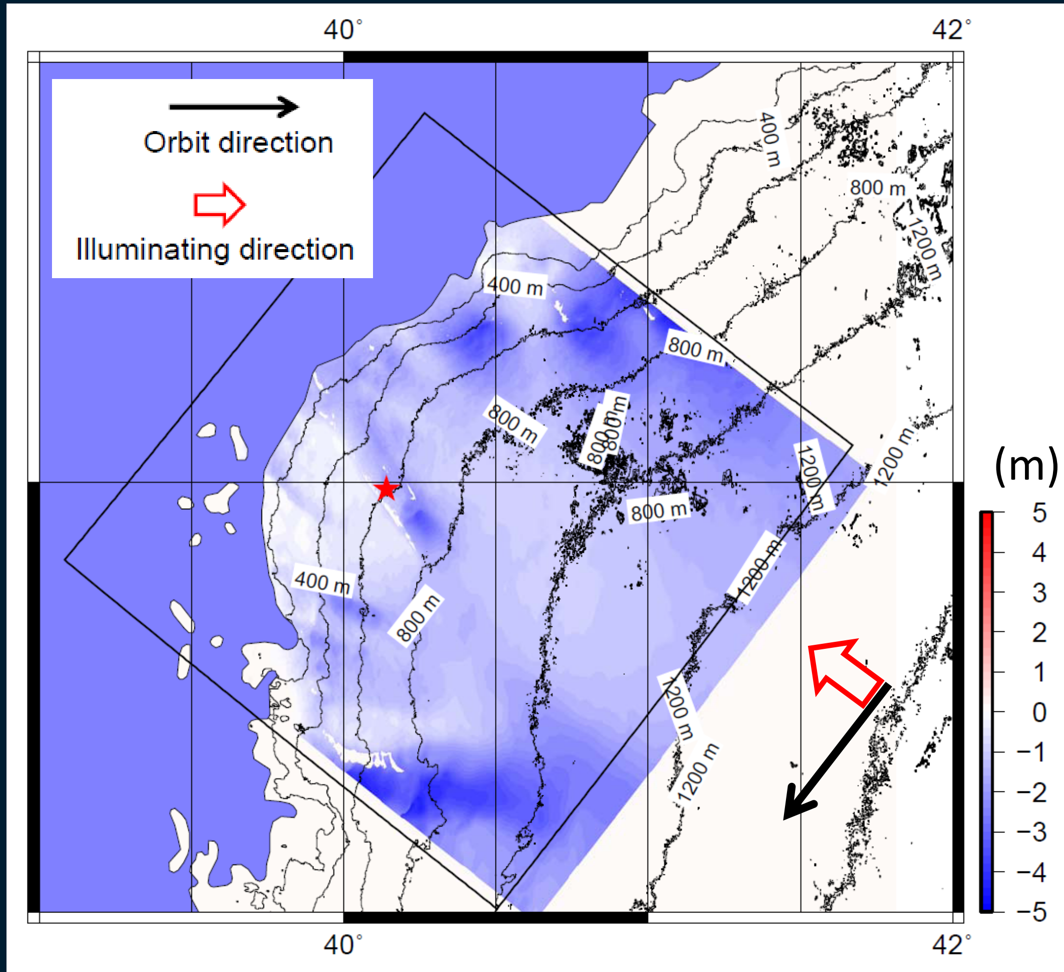
III. Mapping of ice sheet flow velocity

- DInSAR, use of GDEM

Comparison of flow velocity with that measured by GPS

	Period	Flow rate (cm/day)
PALSAR	2010/6/9 – 2010/7/25	3.0 (LOS)
GPS	2012/5/2 – 2012/5/11	14.9

Location of GPS site is (-69.008N, 40.139E), which is indicated by an asterisk in the figure.



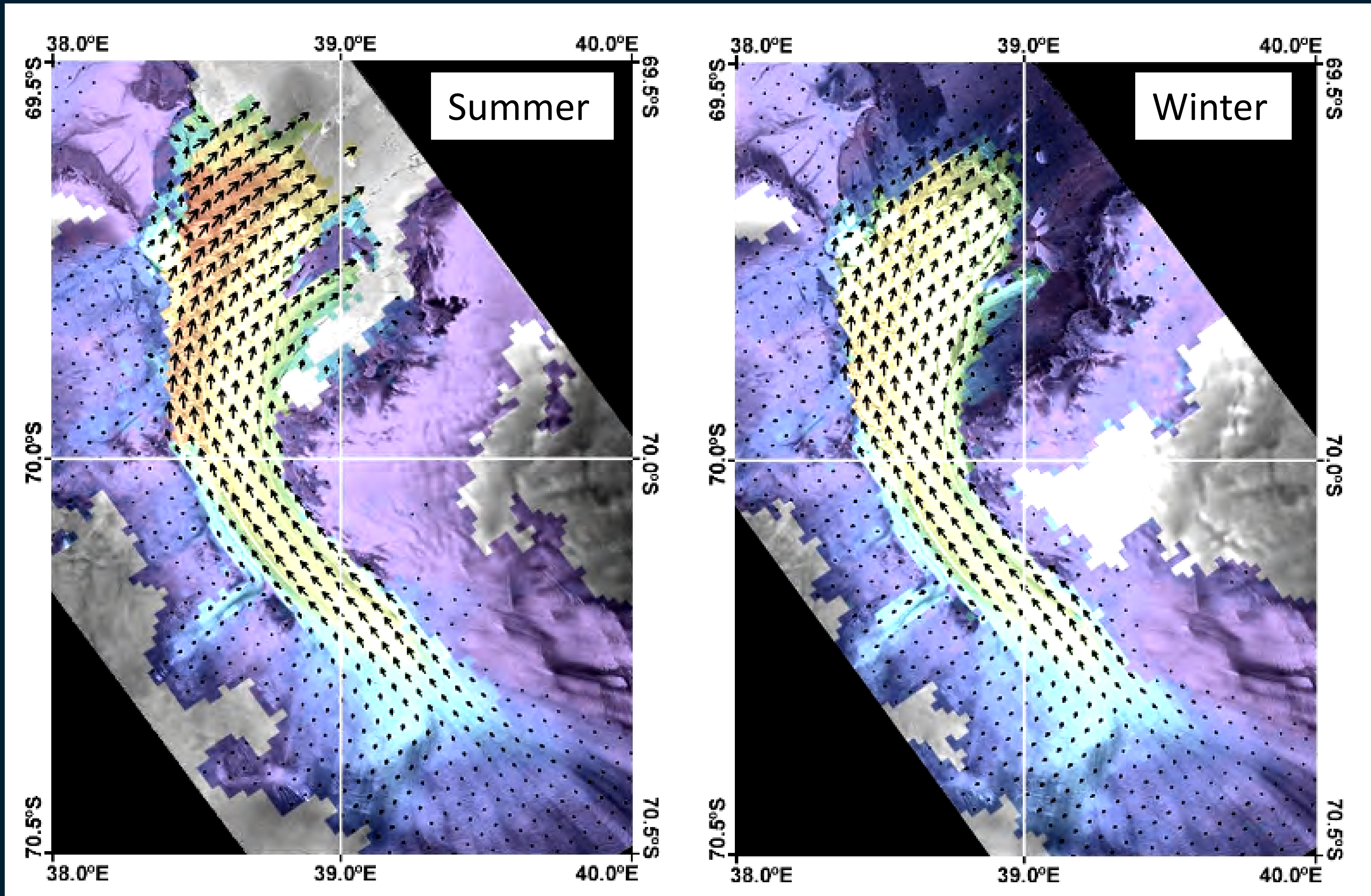
2010/06/09-2010/07/25

Red: approaching to the satellite

Blue: getting away from the satellite

IV. Mapping of ice sheet flow velocity

- Offset tracking

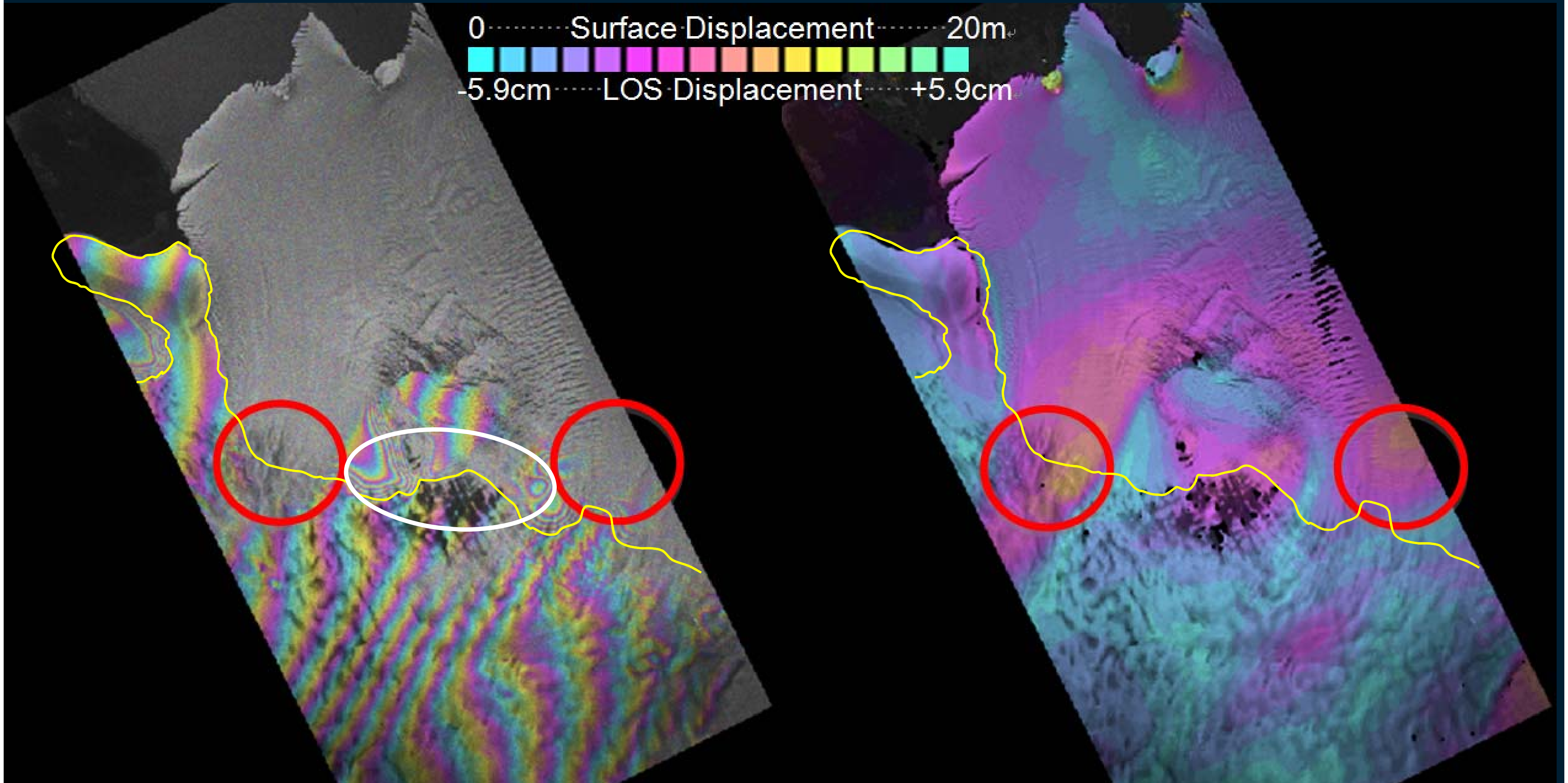


December 2007 – February 2008

June 2008 – August 2008

V. Extraction of grounding line

- Challenging, long revisit cycle

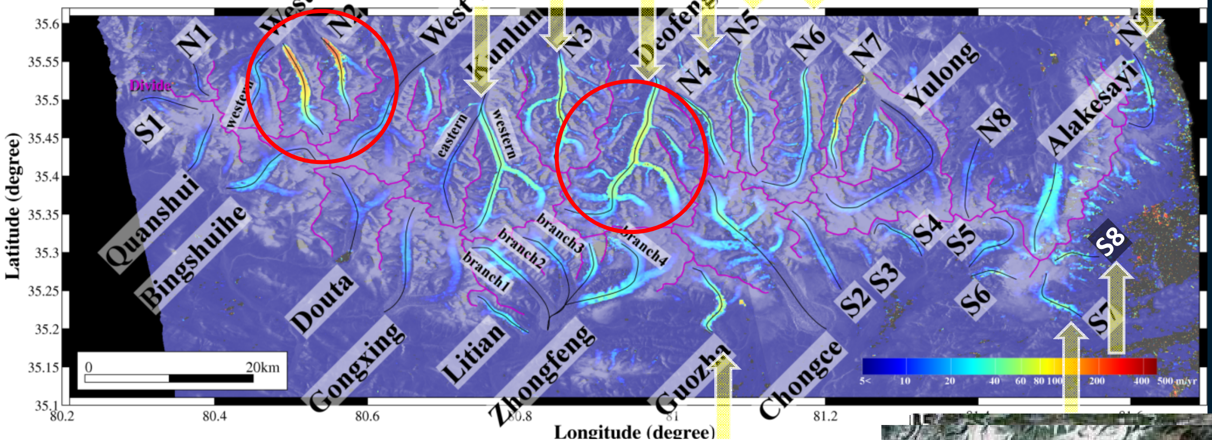


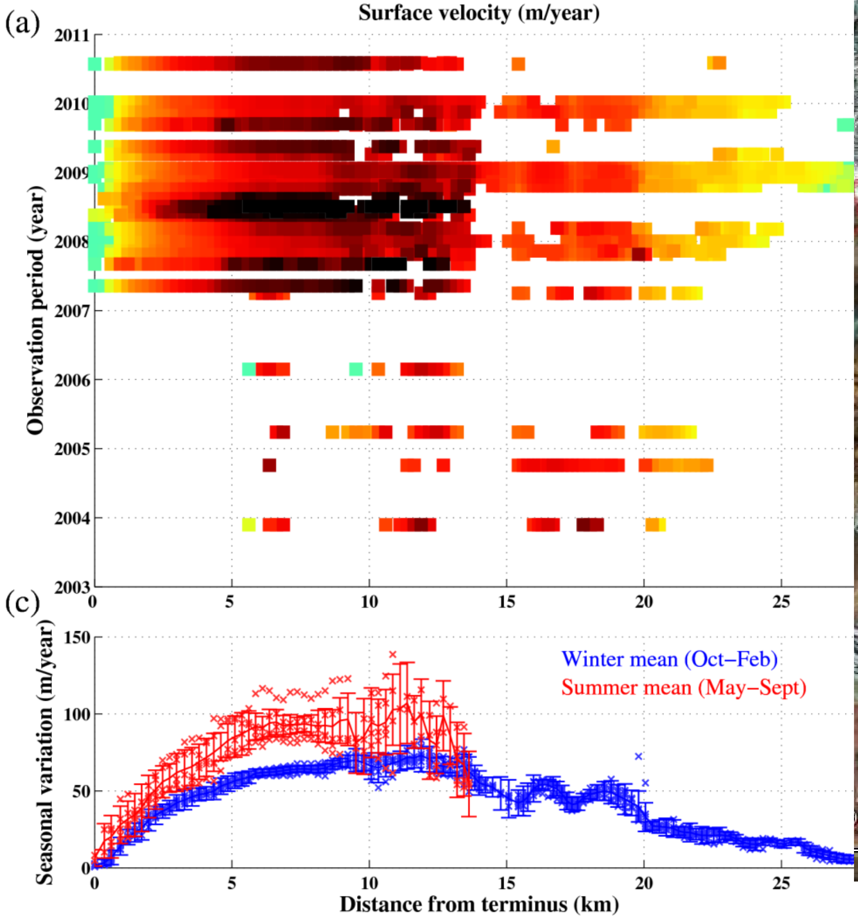
Grounding line and ice sheet flow velocity analysis result using ALOS / PALSAR data on Lazarevisen, Dronning Moud Land. Left view (a) shows the grounding line extracted by differencing of two interfroegram and right image (b) shows the flow velocity field estimated by offset tracking analysis using two images. Position of fast flow area coincide with decorrelated area on interferogram.

VI. Applications to mountain glacier

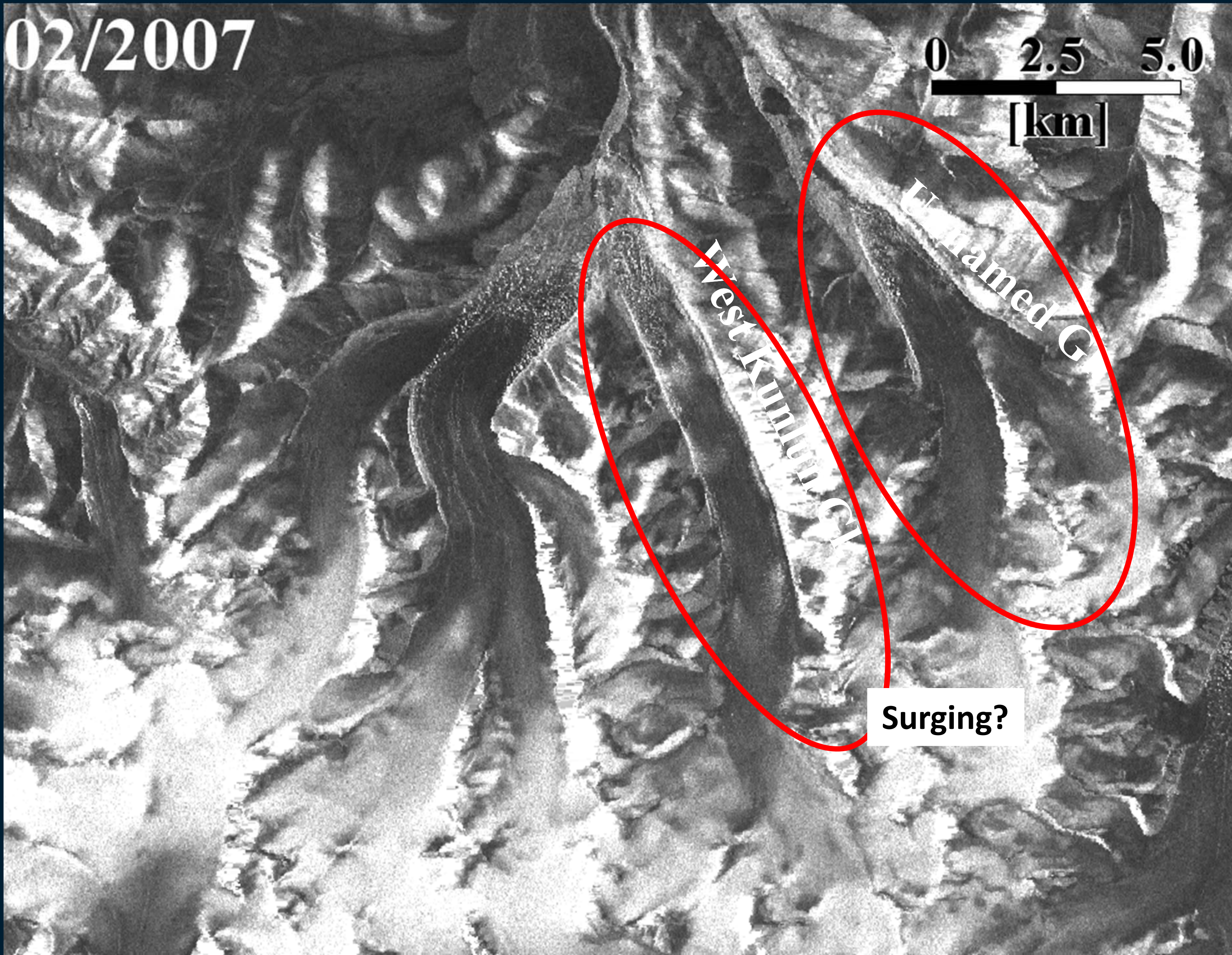
Mountain glaciers in West Kunlun

(Yasuda & Furuya, 2013 *Remote Sens. Environ.*,)





Intensity image(path516, Feb. 2007 – Feb. 2011, 13 scene)



Yasuda and Furuya (2013, *Remote. Sens. Environ.*)

Remaining Issues for SAR data utilization

Application side:

- Use of Coherence
  - snowfall mapping
  - monitoring of permafrost melting
- DEM generation
  - For higher latitude area than SRTM coverage.
  - ASTER GDEM is available, but not perfect
  - Problem of penetration depth of microwave to ice sheet

Hardware / operation system:

- Revisit cycle
  - Improvement of interferometric coherence
- Wide area observation
  - For monitoring of sea ice condition
  - With polarimetric observation, if possible
- Use of polarimetry
  - Present polarimetry observation is still experimental mode
  - Expectation of operational data availability

Expectations to the Next Generation SAR (NG-SAR)

NG-SAR: Employ Digital Beam Foaming system and twin satellites

- High observation frequency (twin satellites)
- Wide swath Stripmap observation
- Improve the chance to observe full polarimetry

Expected Sensor Mode of NG-SAR (at 30, April, 2013)

Mode ID	Azimuth res.	Band width	Swath width (max)	Polarization	InSAR orbit
1	10 m	20 MHz + 5 MHz （ionospheric corr.）	350/175 km	Single/Dual/Full	Repeat/Single Strip map
3	10 m	80 MHz	175 km	Full	Single
4	10 m	80 MHz	175 km	Full	Repeat Stripmap
5	1 m	80 MHz	50 km	Single/Dual/Full	Repeat/Single
6	3 m	80 MHz	350 /175km	Single/Dual/Full	Repeat/Single
7	50 m	20 MHz	350/175 km	Single/Dual/Full	Repeat/Single ScanSAR type

Mode 4 (10 m, 175km, Full Pol., Repeat pass）
(able to alternate to mode 7)

items	Target area	Observation frequency and season	Remarks
Sea Ice detection	Okhotsk Sea	Dec. – Apr. Interval : 1-4day	Resolution :100m Swath :350km is preferable Full pol is preferable
Sea Ice detection	Arctic Sea Antarctic Sea	Monthly (Weekly is preferable)	ditto

Expectations

- Improvement in sea ice detection accuracy (with full polarimetry, for JCG)
- detecting melt pond distribution
- Useful for study on ice edge
  => Difficult to study with microwave radiometer data

Mode 6（3 x 3 m, 350 / 175km, Single/Dual/Full pol., Repeat) 1/2

items	Target area	Observation frequency and season	Remarks
Glacier flow velocity estimation	Glacier, ice sheet	Monthly, Full Year	Offset tracking Inc. angle :40deg Need obs. Of Pole
	Glacier, ice sheet	8days interval, continuous obs.	3-pass InSAR
Grounding line extraction	Marginal zone of Antarctic coast line	8days interval, continuous obs.	3-pass InSAR

Expectations

- Make velocity map of entire Antarctic continent / Greenland (need observation of pole)
- Improvement in the InSAR coherency
- Update the position of grounding line mainly developed by ERS-1/2 InSAR (1995-96)
- Provide useful estimation for mass balance study on Antarctica / Greenland

Mode 6（3 x 3 m, 350 / 175km, Single/Dual/Full pol., Repeat) 2/2

items	Target area	Observation frequency and season	Remarks
Monitoring of Northern Sea route	Arctic sea	Every day Summer season	Full pol. or (HH+VV) High Inc. angle
Melting of permafrost on boreal forest	Siberia, Alaska	Every cycle May-October	Dual (HH+HV), Intensity image, InSAR

Expectations

For Northern Sea route:

- Provide practical information about safe marine navigation with the aid of quick supply to customer

For permafrost monitoring:

- Provide information about greenhouse gas emission and land subsidence

Summary (1/2) From ALOS / PALSAR data,

Sea ice detection:

Succeeded in operational use at Okhotsk sea by JCG.
Deepen understanding the polynya and AABW formation at Cape Darnley, Antarctic sea

Ice sheet / glacier flow monitoring:

Accurate and broad understanding of glacier flow velocity

Grounding line detection:

Succeeded to extract grounding line by PALSAR data applying 3pass InSAR
Relationship between flow velocity and coherency

Summary (2/2) From Next Generation SAR data,

Sea ice detection:

- Improve the observation frequency (two satellites in 4 days interval)
- Full polarimetric observation (DBF technology) will improve the detection accuracy
- New scientific findings like distributions of melt pond, deep understanding of AABW source and so on.

Flow velocity monitoring :

- Improve the InSAR coherency bring in the clear interferogram
- Update the flow velocity map, find out the acceleration => useful for mass balance study

Grounding line detection:

- Improve the InSAR coherency bring in the clear interferogram
- Update the grounding line position => useful for mass balance study

Northern sea route:

- Frequent and wide observation enables the support of safe marine navigation

Monitoring of permafrost melting:

- Greenhouse gas (methane, co2) emission
- land subsidence

Acknowledgements

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  T. Yamanokuchi (RESTEC)

  K. Doi (NIPR)