

InSAR를 이용한 남극 장보고 과학기지 주변 정착해빙의 연간 변화 관측

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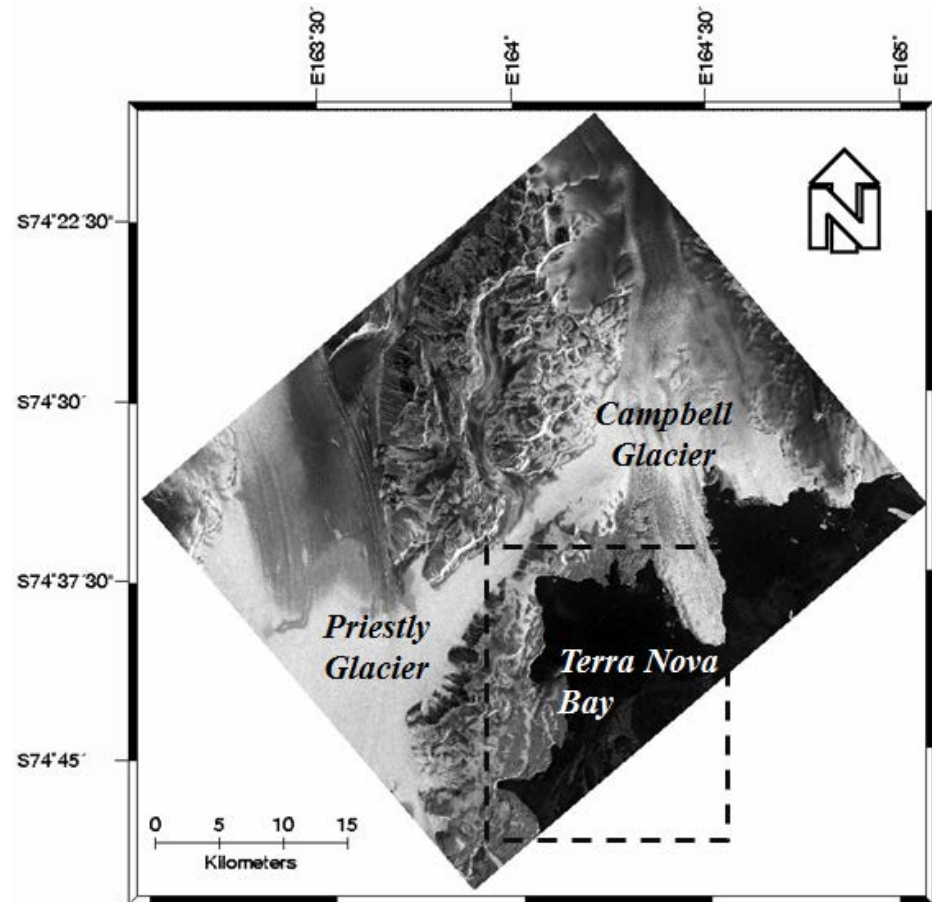
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Objectives

- To map the annual variation of landfast sea ice extent near Jang Bogo Research Station
- To understand the strain field on landfast sea ice

Landfast Sea Ice near Jang Bogo Station

- A section of Terra Nova Bay (TNB), East Antarctica
- Landfast sea ice near Campbell Glacier Tongue (CGT)
- Landfast sea ice near TNB affect logistics of research stations
 - Jang Bogo Station, Korea (74°37'04"S, 164°13'07"E)
 - Mario Zucchelli Station, Italy



Dataset

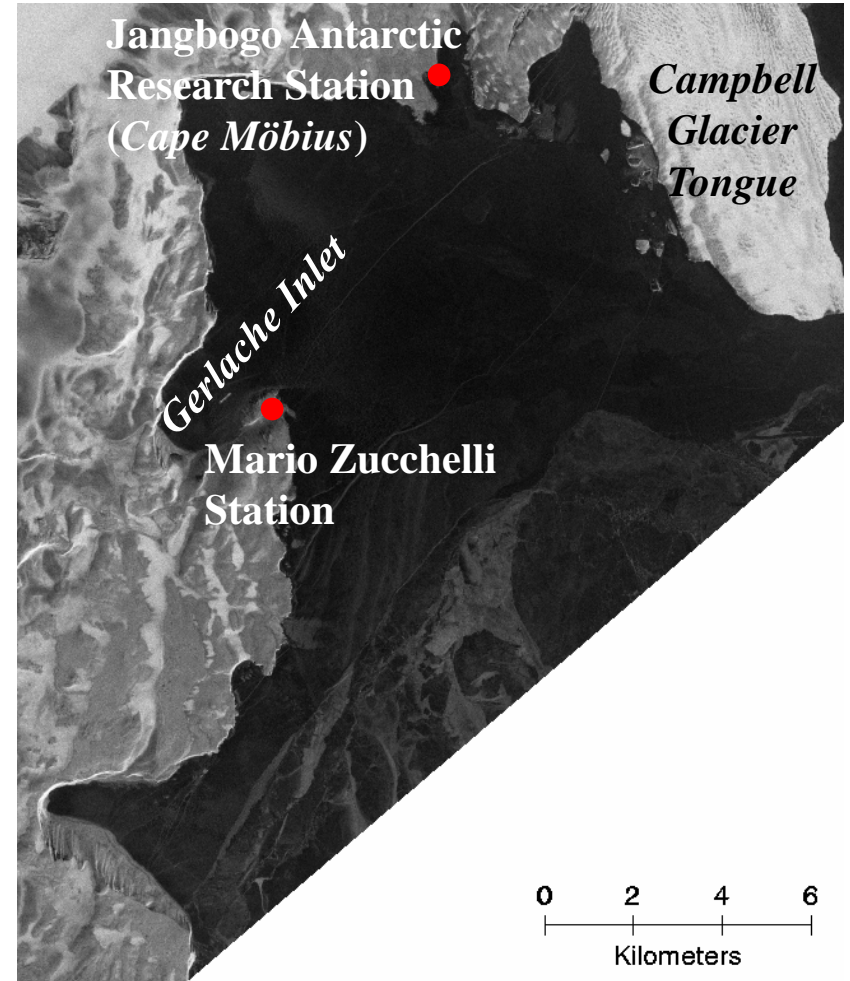
- **COSMO-SkyMed (CSK) Constellation**

- X-band, strip map, 3 m resolution, VV-pol, descending orbit
- 14 months of observation period from Dec. 2010 to Jan. 2012
- 20 one-day InSAR from CSK1 and CSK2 with 16-day repeat cycle
- 17 weekly InSAR combining CSK3 with 8-day offset

Dates of InSAR pair (yyyy/mm/dd)	Temporal baseline (day)	Dates of InSAR pair (yyyy/mm/dd)	Temporal baseline (day)
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

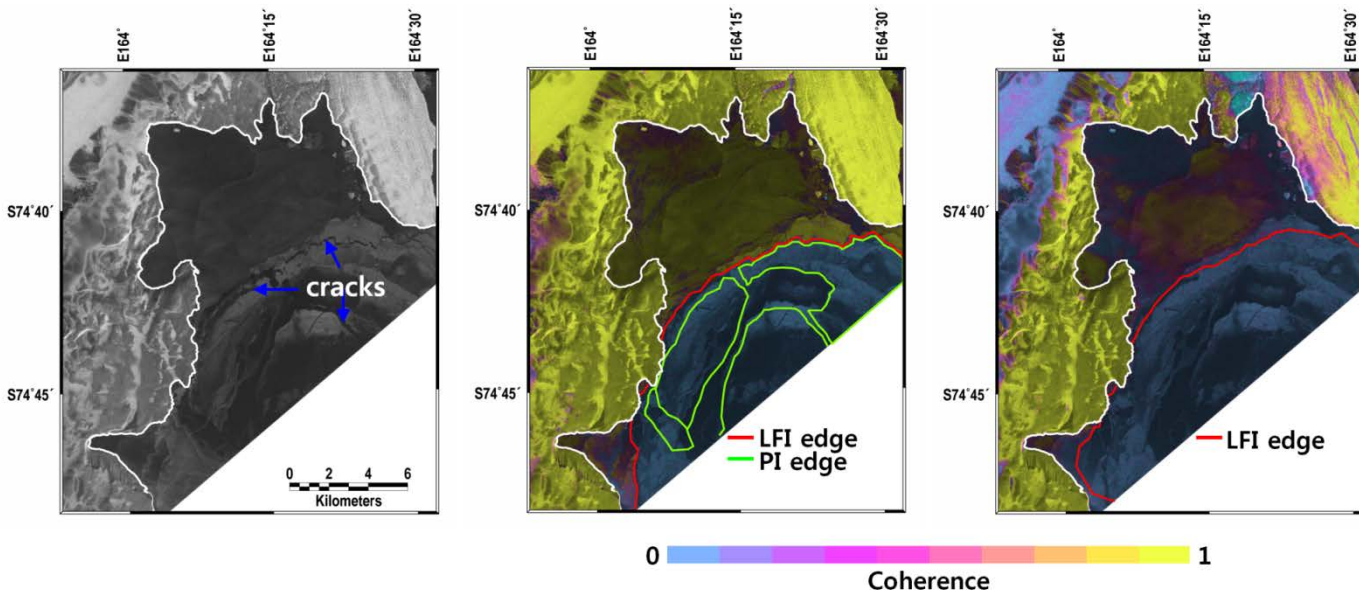
Region of Interest for Sea Ice Extents

- A coastal section of Terra Nova Bay, West of Campbell Glacier Tongue
- Image area of common coverage of CSK images

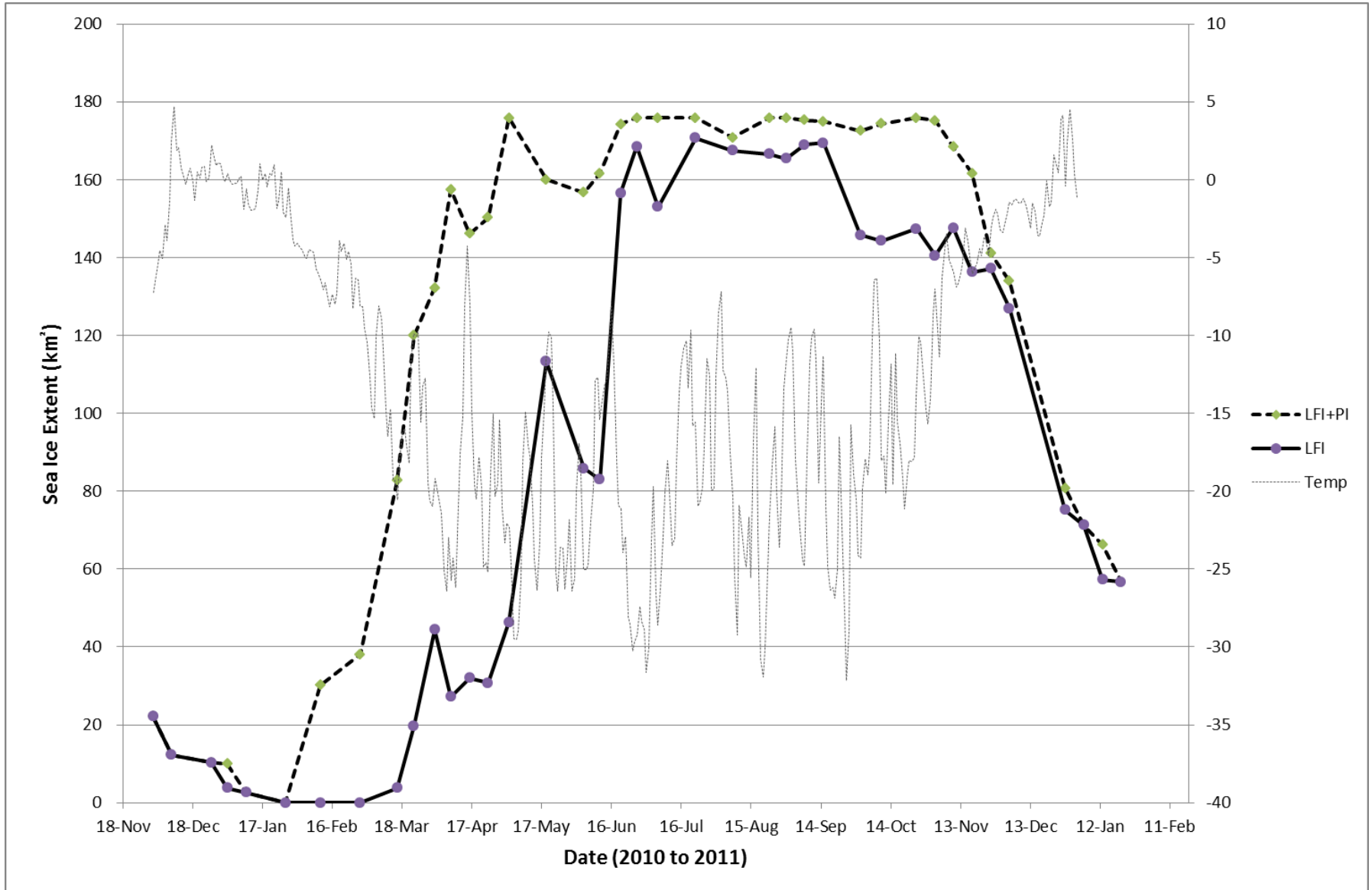


Classification

- Fast ice
 - High coherence in one-day InSAR
 - Strain rate less than a quarter of SAR resolution ($\sim 3/4$ m)
- Pack ice
 - Low coherence, cracks and leads
 - Traceable by multi-temporal SAR images
- Ocean
 - Low coherence, dark in calm days (or nilas, frazil ice)
 - Polynya with katabatic winds

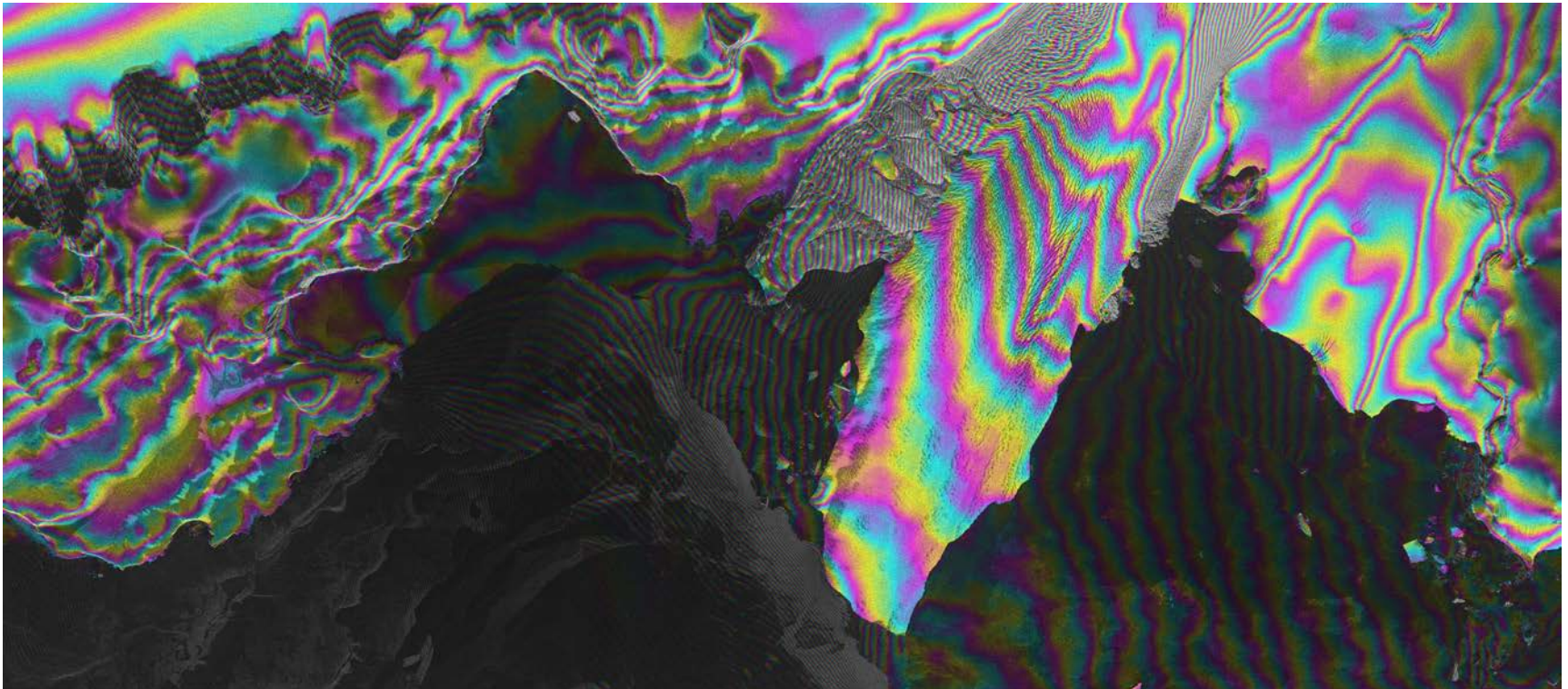


Sea Ice Extent



Strain field on landfast sea ice

- An example of one-day InSAR



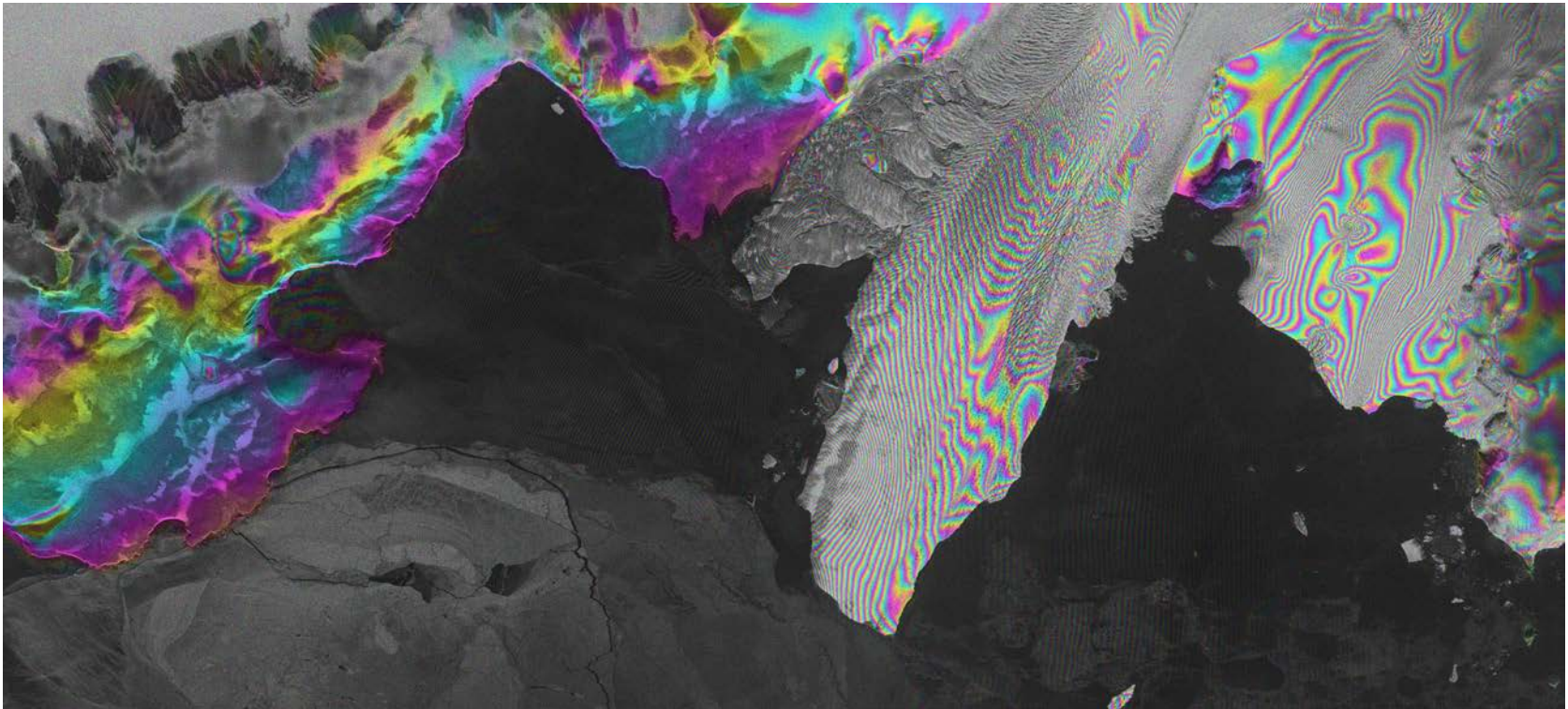
**One-day interferogram
(2011/05/03 ~ 2011/05/04)**

Fast Ice Stress

- Air Stress
 - No correlation with fringes
 - Water Stress
 - No correlations with fringes
 - Coriolis Force
 - fast ice
 - Adjacent sea ice
 - Can not explain the year-long consistency in sea ice fringe
 - **Sea Surface Tilt**
 - Some correlations with fringes near sea shore
 - **Campbell Glacier Tongue**
 - Very complex especially in west of CGT
 - Fringe rate and direction varies
- ✓ Tidal strain is oscillatory while CGT strain is cumulative -> Weekly InSAR

Strain field on landfast sea ice

- An example of weekly InSAR



**Weekly interferogram
(2011/06/04 ~ 2011/06/11)**

Weekly InSAR Observations

- Weekly InSAR images verify cumulative glacial strain with equi-strain line (fringes) parallel to the glacial contact.
- Fast ice to the east side of CGT is strongly affected by glacial stress.
- Some section of fast ice to the west of CGT, in contact with CGT, is also affected by glacial stress.
- Fast ice near the shoreline, isolated from CGT by cracks and leads, shows tidal strain only.

Glacial and Tidal Stresses

- Glacial Stress
 - Campbell Glacier Tongue has a year-long steady motion of ~ 67 cm/day (Han and Lee, 2014, 2015)
 - Equi-strain fringe is parallel to the glacier tongue-landfast sea ice contact
 - Glacier tongue-landfast sea ice contact in the east of CGT is established between mid May and early June
- Tidal Stress
 - Tide generates ocean surface tilt (~ 40 cm)
 - Tidal strain fringe is parallel to the shoreline
 - Affected by tidal current, CGT and ocean bottom topography
- Glacial and tidal strain rates are similar in **one-day InSAR**
- **Glacial strain** is dominant in **weekly InSAR** because CGT gives cumulative stress (~ 469 cm/week) while tide is oscillatory (~ 40 cm).

Conclusions

- One-day and weekly InSAR observation enabled the observation of annual variation of landfast sea ice and its dynamics.
- Landfast sea ice lags air temperature by two months in Terra Nova Bay.
- InSAR fringes on landfast sea ice near Jang Bogo Station are mainly from glacial stress and tidal stress.
- Weekly InSAR highlights consistent glacial strain (~469 cm/week).

감사합니다.