ESA–MOST Dragon Cooperation
中国科技部-欧洲空间局“龙计划”合作

2017 DRAGON 4 SYMPOSIUM
2017年“龙计划”四期学术研讨会

First Gaofen-3 SAR Interferometry

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26–30 June 2017 | Copenhagen, Denmark
2017年6月26-30日，丹麦 哥本哈根

Gaofen-3 SAR satellite

- 12 different working modes
- Wide incidence angles
- Dual-polarization
- High-resolution (1 m) to extremely-wide-swath (650 km)
- quick site access time of 3.5 days at most (1.5 day at 90% probability)
- 8 years of design life

Gaofen 3 satellite
(launched on 10/08/2016)

The first Chinese multi-polarized C-band SAR satellite

Gaofen-3 SAR satellite

Image mode		Resolution(m)			Width(km)		Incidence(°)	Looks A×E	Polarization
		Nominal	Azimuth	Range	Nominal	Area			
Spotlight		1	1.0~1.5	0.9~2.5	10×10	10×10	20~50	1×1	Optional single-polarization
Ultra Fine stripmap		3	3	2.5~5	30	30	20~50	1×1	Optional single-polarization
Fine stripmap 1		5	5	4~6	50	50	19~50	1×1	Optional dual-polarization
Fine stripmap 2		10	10	8~12	100	95~110	19~50	1×2	Optional dual-polarization
Stripmap		25	25	15~30	130	95~150	17~50	3×2	Optional dual-polarization
Wide swath 1		50	50~60	30~60	300	300	17~50	2×3	Optional dual-polarization
Wide swath 2		100	100	50~110	500	500	17~50	2×4	Optional dual-polarization
Full polarization stripmap 1		8	8	6~9	30	20~35	20~41	1×1	Full polarization
Full polarization stripmap 2		25	25	15~30	40	35~50	20~38	3×2	Full polarization
Wave image		10	10	8~12	5×5	5×5	20~41	1×2	Full polarization
Global observing image		500	500	350~700	650	650	17~53	4×2	Optional dual-polarization
Extended incidence	low	25	25	15~30	130	120~150	10~20	3×2	Optional dual-polarization
	high	25	25	20~30	80	70~90	50~60	3×2	Optional dual-polarization

Gaofen-3 SAR satellite

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		Nominal	Azimuth	Range	Nominal	Area			
Spotlight		**1**	**1.0~1.5**	**0.9~2.5**	**10×10**	**10×10**	**20~50**	**1×1**	Optional single-polarization
Ultra fine stripmap		**3**	**3**	**2.5~5**	**30**	**30**	**20~50**	**1×1**	Optional single-polarization
Fine stripmap 1		**5**	**5**	**4~6**	**50**	**50**	**19~50**	**1×1**	Optional dual-polarization
Fine stripmap 2		10	10	8~12	100	95~110	19~50	1×2	Optional dual-polarization
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Gaofen-3 SAR acquisitions

Sample SAR acquisitions for InSAR test operations

Mode	Site	Acquisition dates	Perpendicular baseline (m)	Mean coherence
FPS1	Wuhan	20161009 20161107	1745	0.17
FS1	Shanghai	20161114 20170310	598	0.41
FS1	Tianjin	20170217 20170318	250	0.57
FS1	Australia	20170423 20170522	45	0.59

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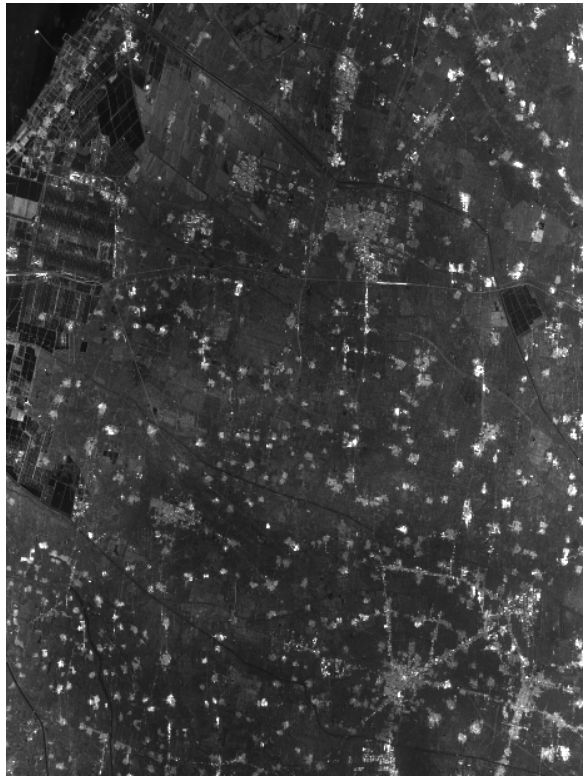

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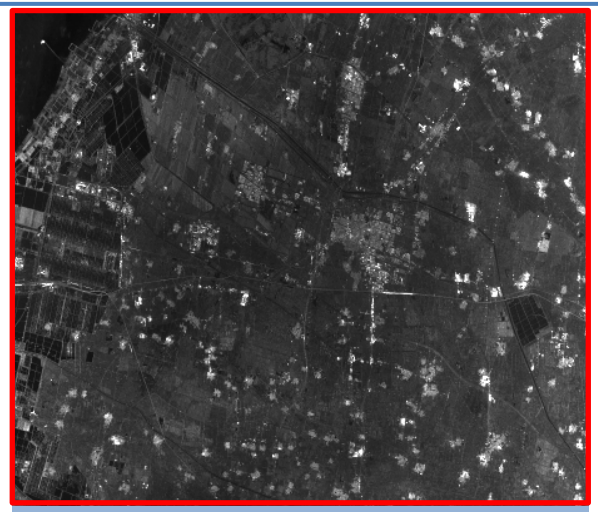
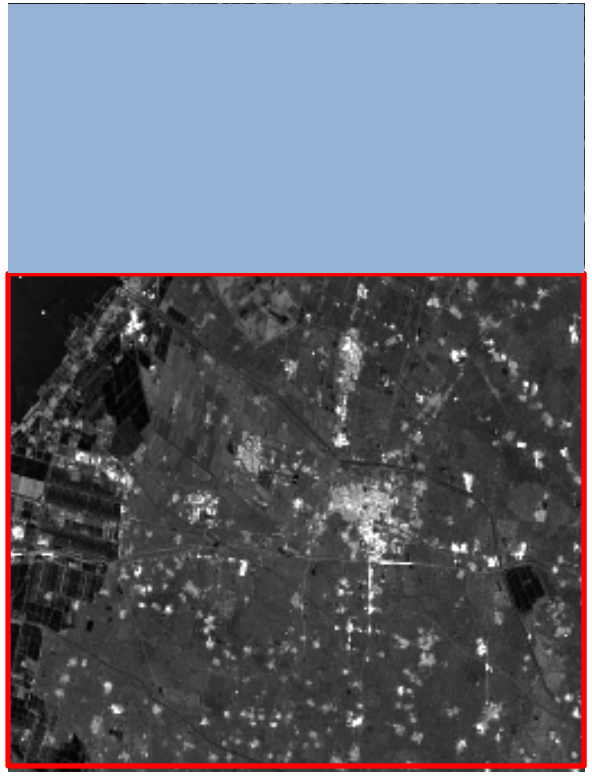


~30%



Gaofen-3 SAR interferometry

Mode	Site	Acquisition dates	Perpendicular baseline (m)	Mean coherence
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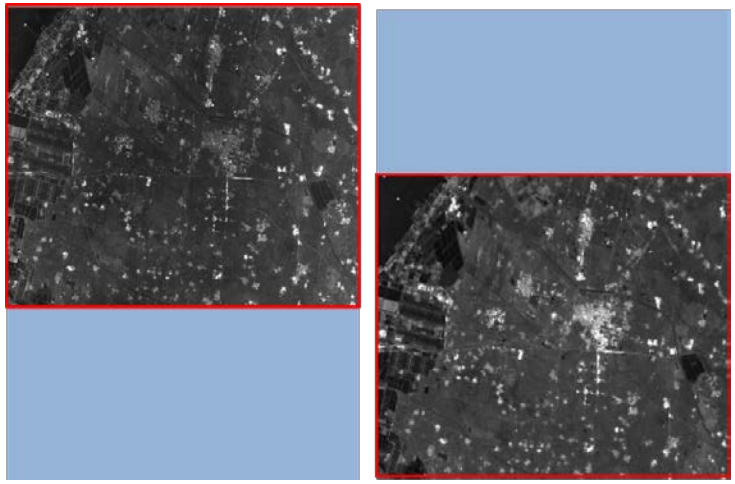
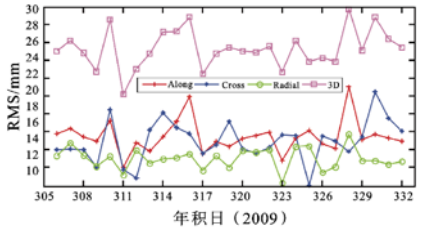


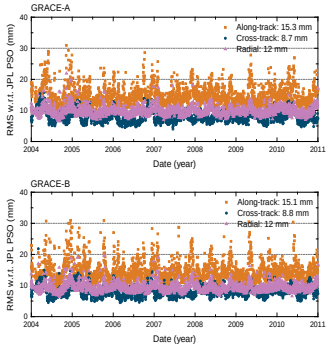
- Coregistration for high-resolution SAR image
- Precise orbit decision

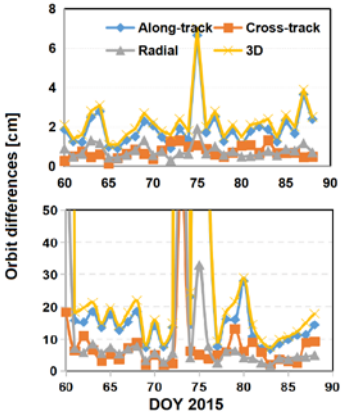
Gaofen-3 Precise orbit determination

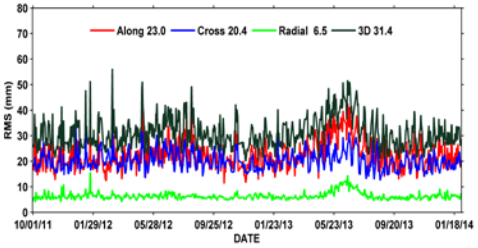
PANDA: Position And Navigation Data Analyzer

Guo et. al. (2015)

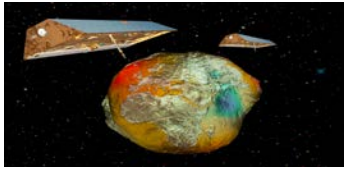






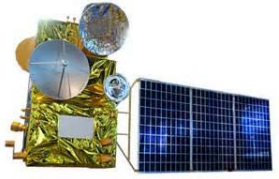


GOCE



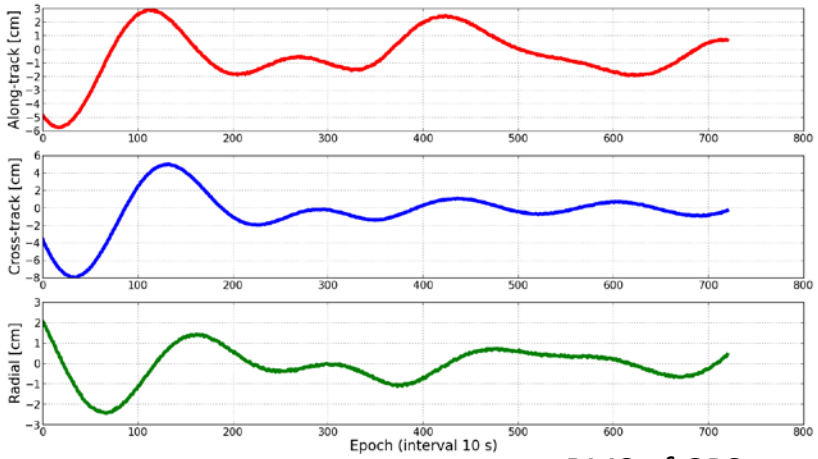
GRACE

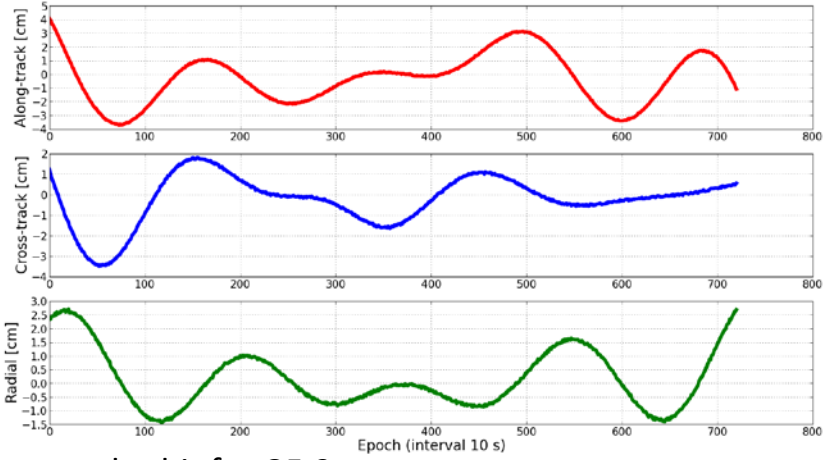
FY3C (Fengyun 3C)



HY2A (Haiyang 2A)

Gaofen-3 Precise orbit determination





RMS of GPS post-processed orbit for GF-3

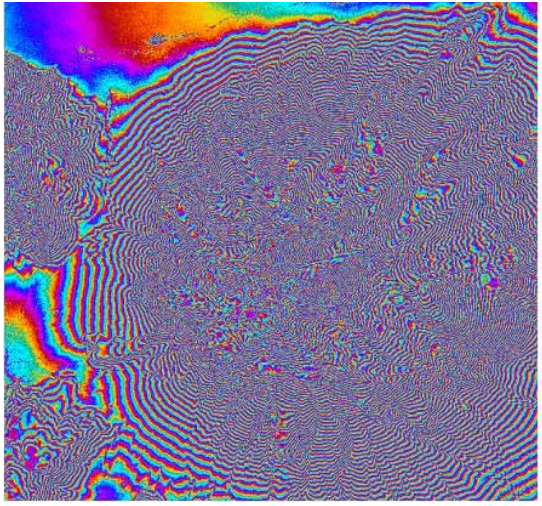
DOY	Along (cm)	Cross (cm)	Radial (cm)	3D (cm)
047, 2017	1.93	2.54	0.86	3.3
076, 2017	1.83	1.18	1.07	2.4

< 5 cm

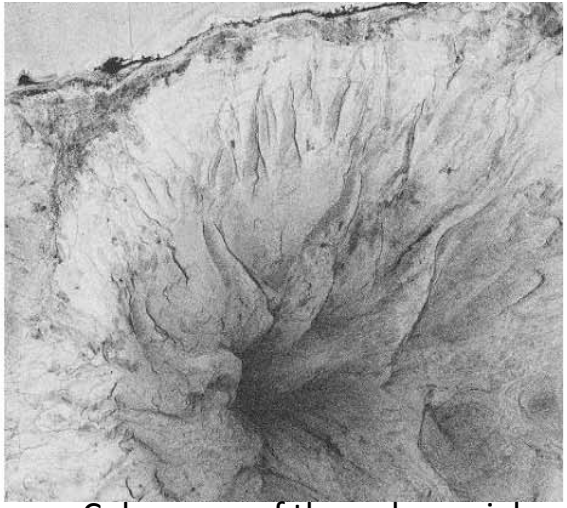
DEM-assisted SAR coregistration

DEM based coregistration
vs.
Polynomial based coregistration

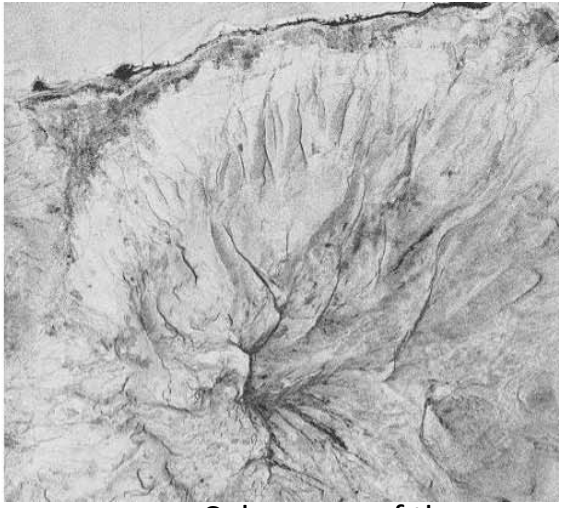
- Large baseline spans
- High temporal resolution
- Different frequency and/or operational modes



Interferogram



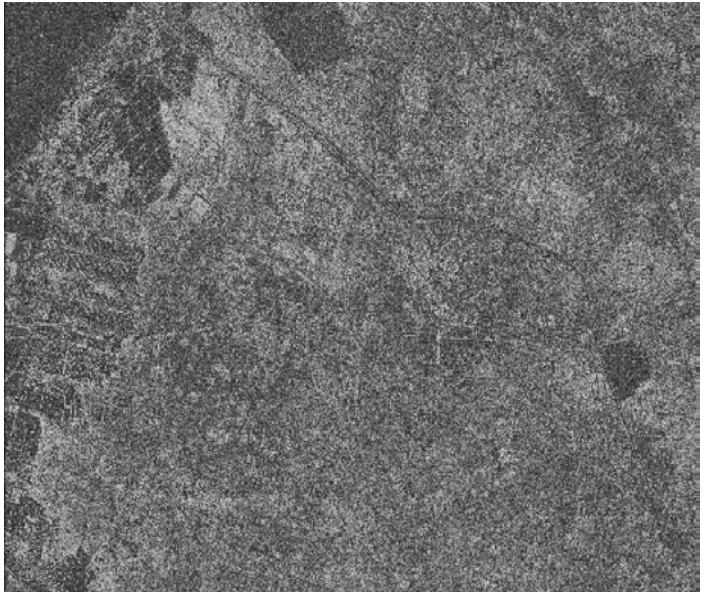
Coherence of the polynomial based coregistration



Coherence of the DEM-assisted coregistration

From Adam et. al. 2017

Gaofen-3 coregistration



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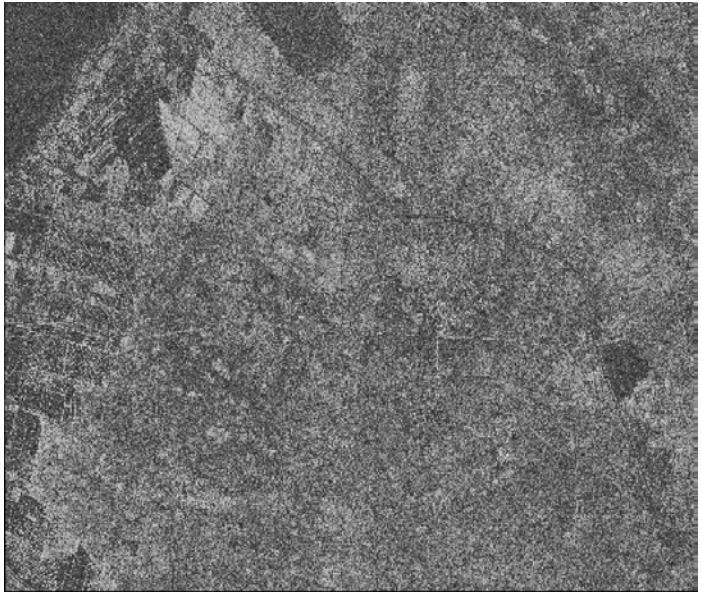
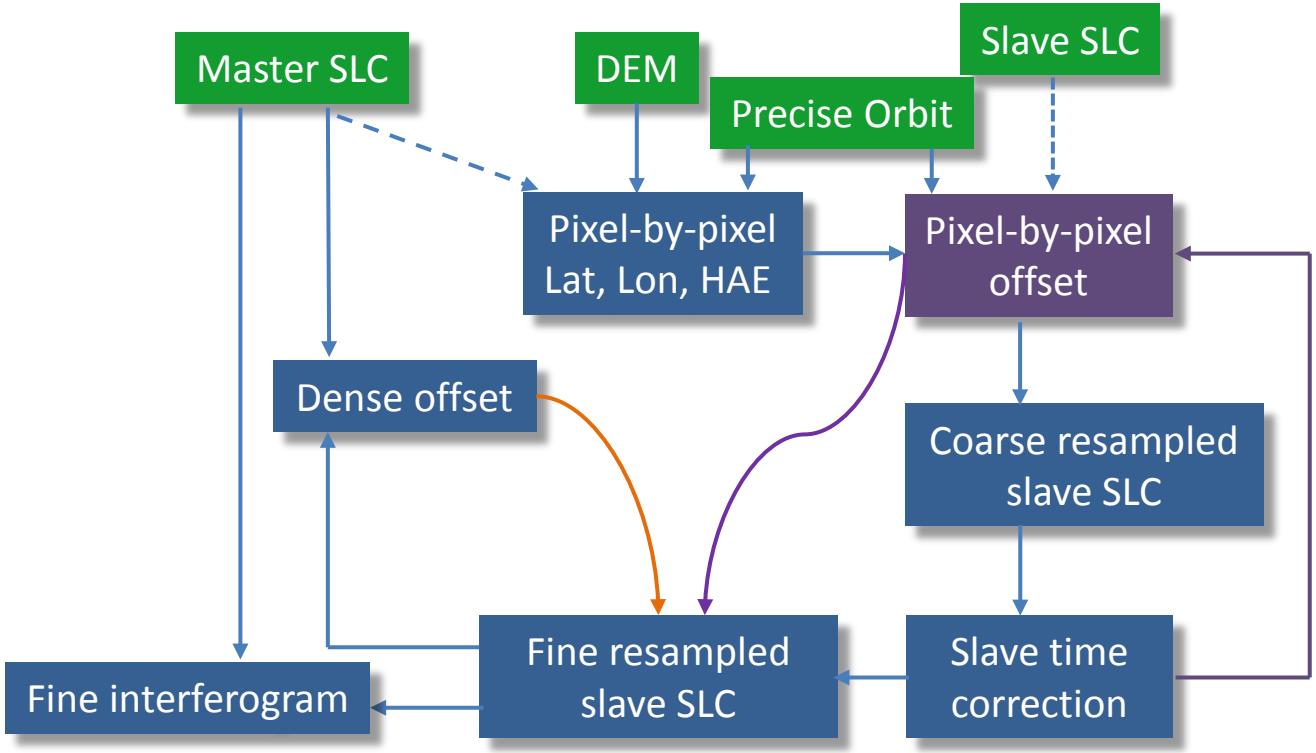


Coherence of the DEM-assisted coregistration

△coherence < 0.005

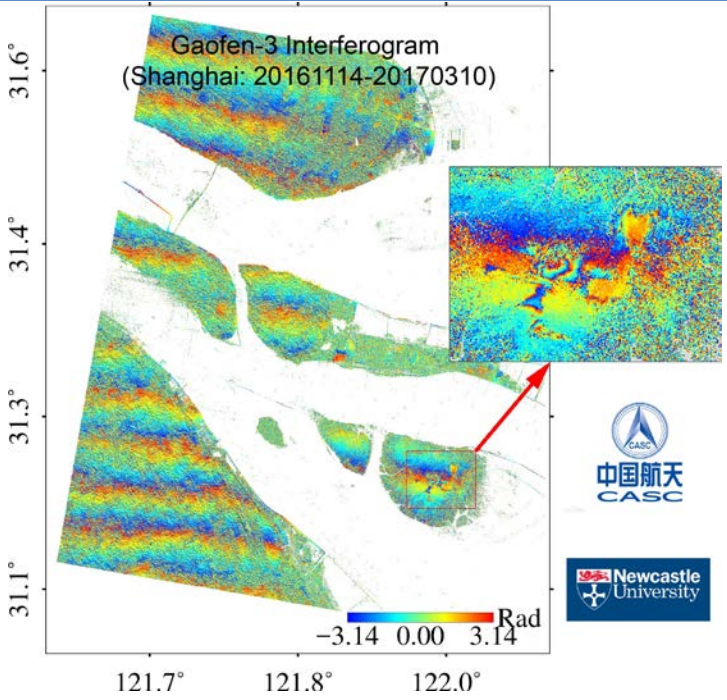
- Small baseline
- Flat topography

Gaofen-3 interferometric processing



Based on ISCE zero-doppler processing

Sample interferograms



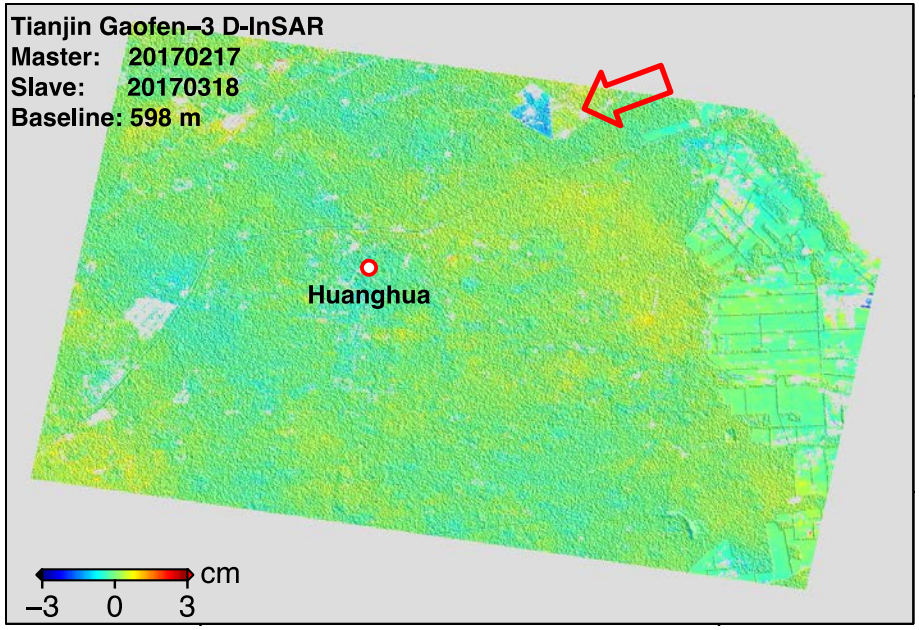
GF-3 interferogram around Shanghai, China

i. Time span: 20161114-20170310, 116 days; Spatial baseline (orbital separation): 598 m;

ii. The long-wavelength parallel fringes are caused by the uncertainties in satellite orbital positions;

iii. About two fringes are observed in the area indicated by a red rectangle, implying c. 5.6 cm of subsidence (likely caused by groundwater extraction) during the 116-day period.

Sample interferograms



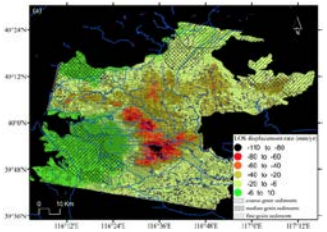
GF-3 interferogram around Tianjin, China

i. A linear plane was removed to get very smooth interferogram;

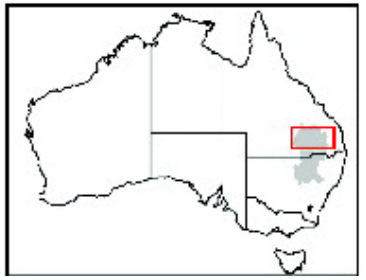
ii. The arrow shows a small jump, shows an uplift of about 1cm.

Ongoing and future work

Three Gorge



Chaoyang district, Beijing



Australia

Ongoing and future work

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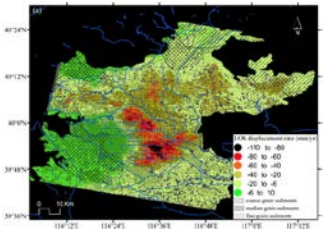

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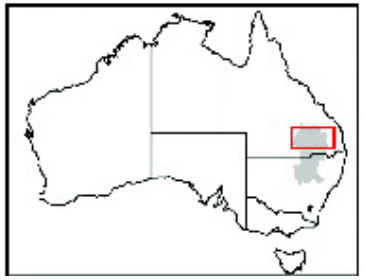

Australia

- Spotlight data
- Landslide
- Spotlight InSAR demonstration

Ongoing and future work

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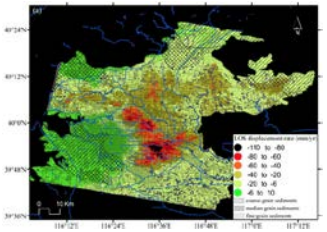
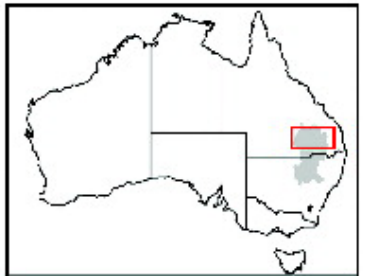


Chaoyang district, Beijing

- Past research using TerraSAR-X and EnviSAT data
- Maximum subsidence of 100 mm/year have been detected
- Continuous monitoring with GF-3



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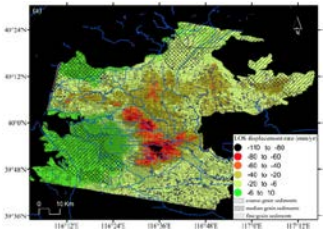

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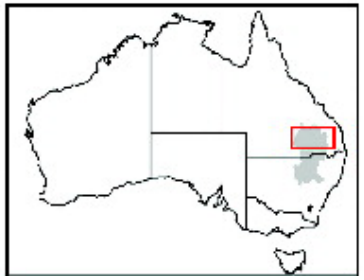

Australia

- Collaboration with Australian Community Safety and Earth Monitoring Division
- 40 corner reflectors
- GF-3 ability to InSAR validation

Summary

- Gaofen-3 shows interferometric ability, and it shows same properties with current modern SAR satellite images;
- An accurate processing chain has been developed for Gaofen-3 based on ISCE;
- Applications in subsidence, landslide, and InSAR validation are making with GF-3 SAR Interferometry.

Thank you!