



Mapping Collapsed Building in Earthquake by Using Polarmetric SAR

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Outline

- Advantages of PolSAR for Mapping Collapsed Building
- Method
- Applications



Advantages of PolSAR

- All weather condition, active Remote Sensing
- PolSAR sensitive to structure and direction
- Different mechanism with optical remote sensing



Challenges

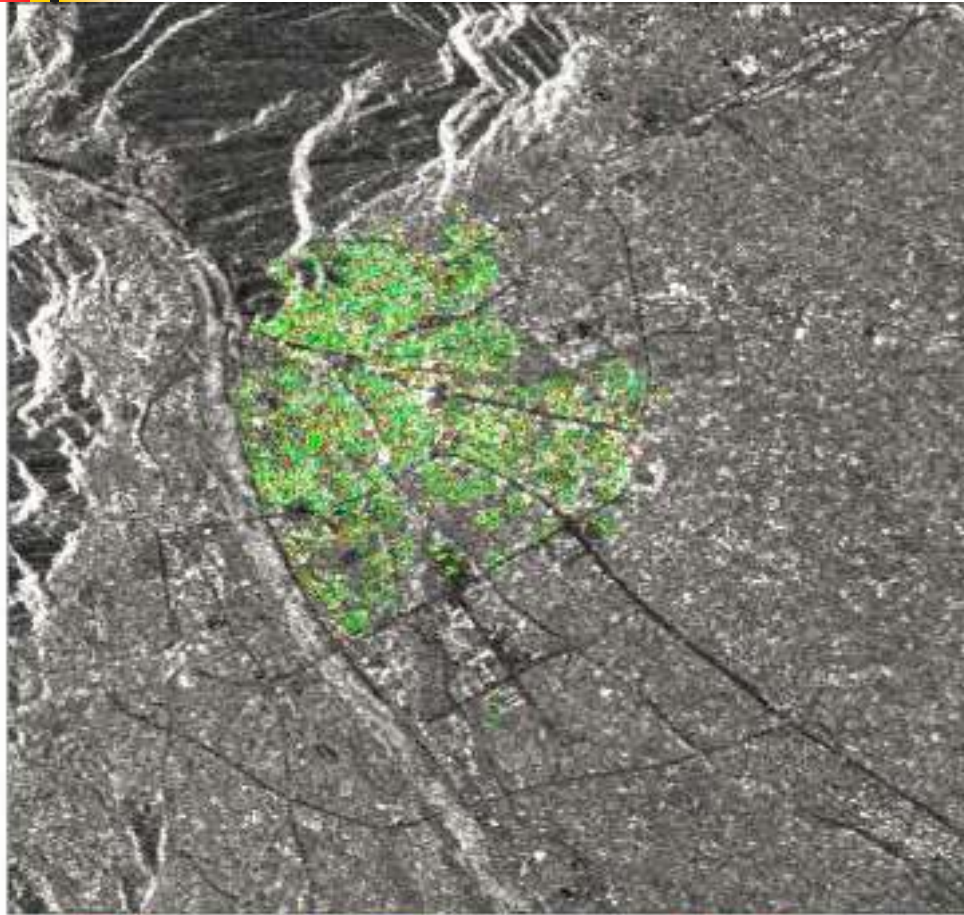
- Resolution
- Speckles
- Imaging Geometry
- Diversity of building types



Research Progress

- Combine of prior and post earthquakes, change detection by using
 - Intensity
 - Texture
 - Coherence
 - Combination of above
- Polarmetric decomposition

Wenchuan Earthquake by ASAR (Dr. Lixia Gong)



完好建筑物 中等破坏建筑物 损毁建筑物



完好建筑物 中等破坏建筑物 损毁建筑物

Data: 2008年3月3日、2008年7月21日，20m，

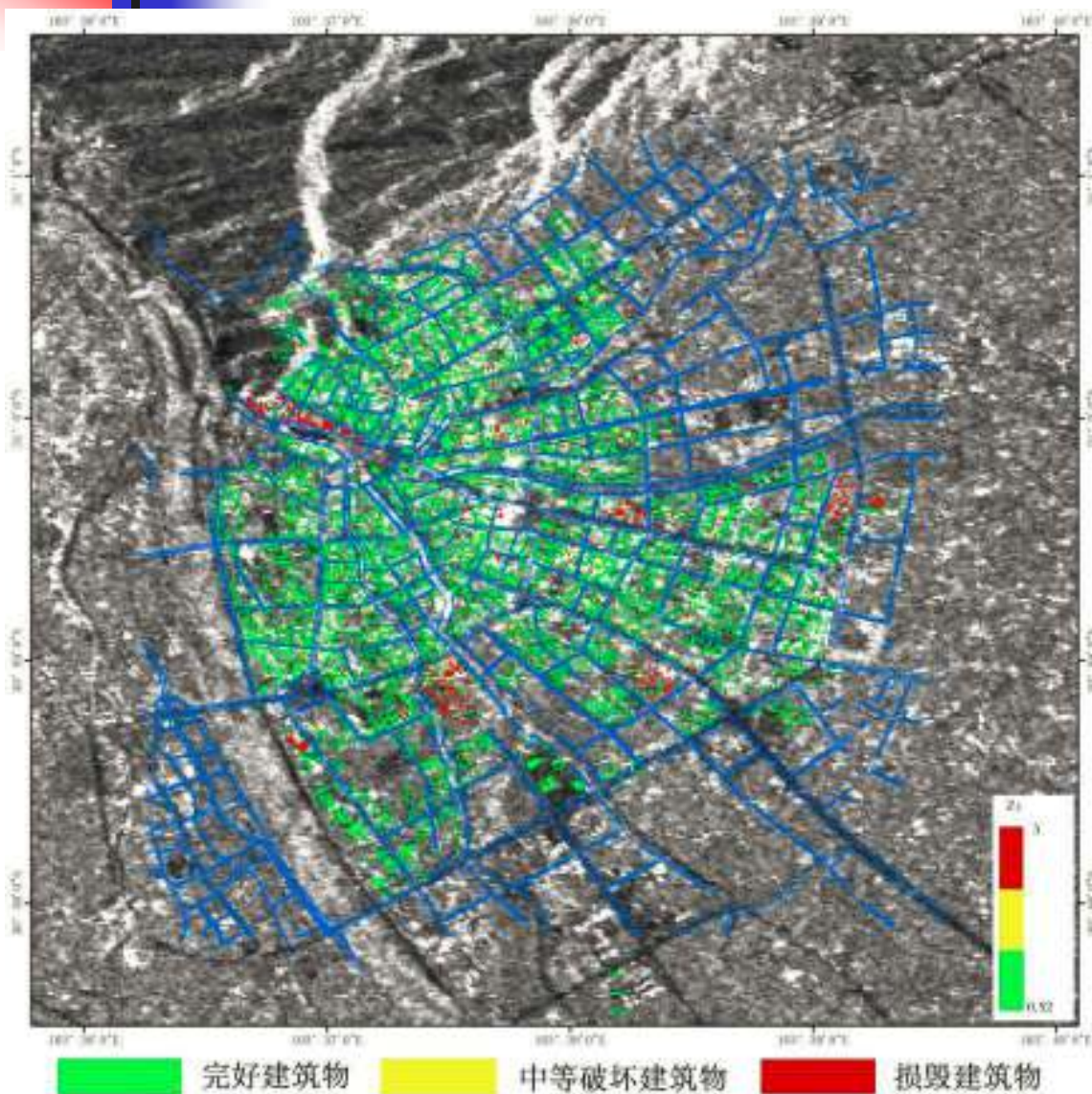
Intensity correlation and difference of backscattering coefficient (Nojima Method);



Accuracy

Category	accuracy/%	ignorance/%	Missing/%
Intact	51.2	48.7	23.5
medium	80	19.78	88
Collapsed	56.89	43.1	15.25
Overall		52.86%	

Refined by training data

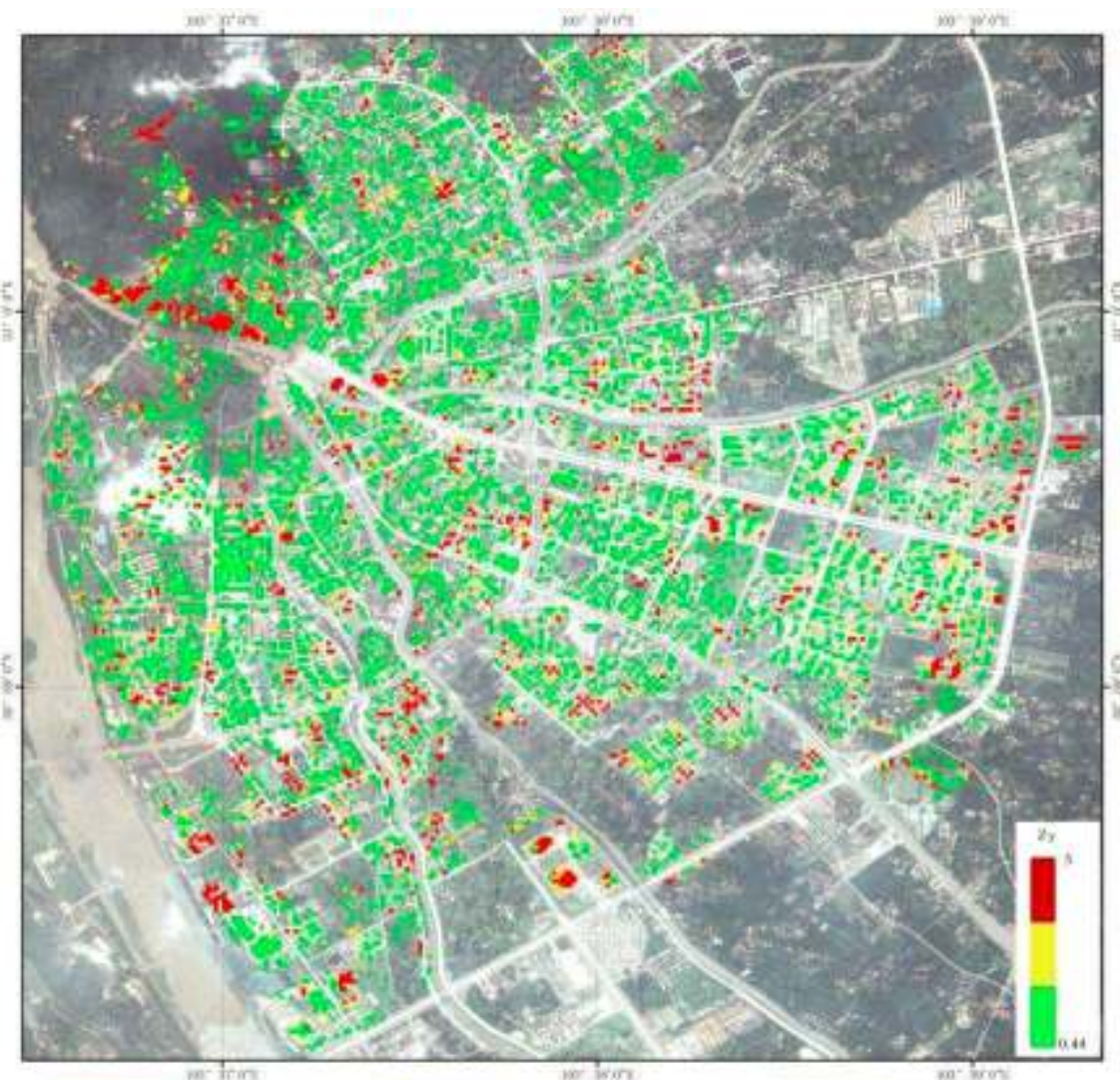
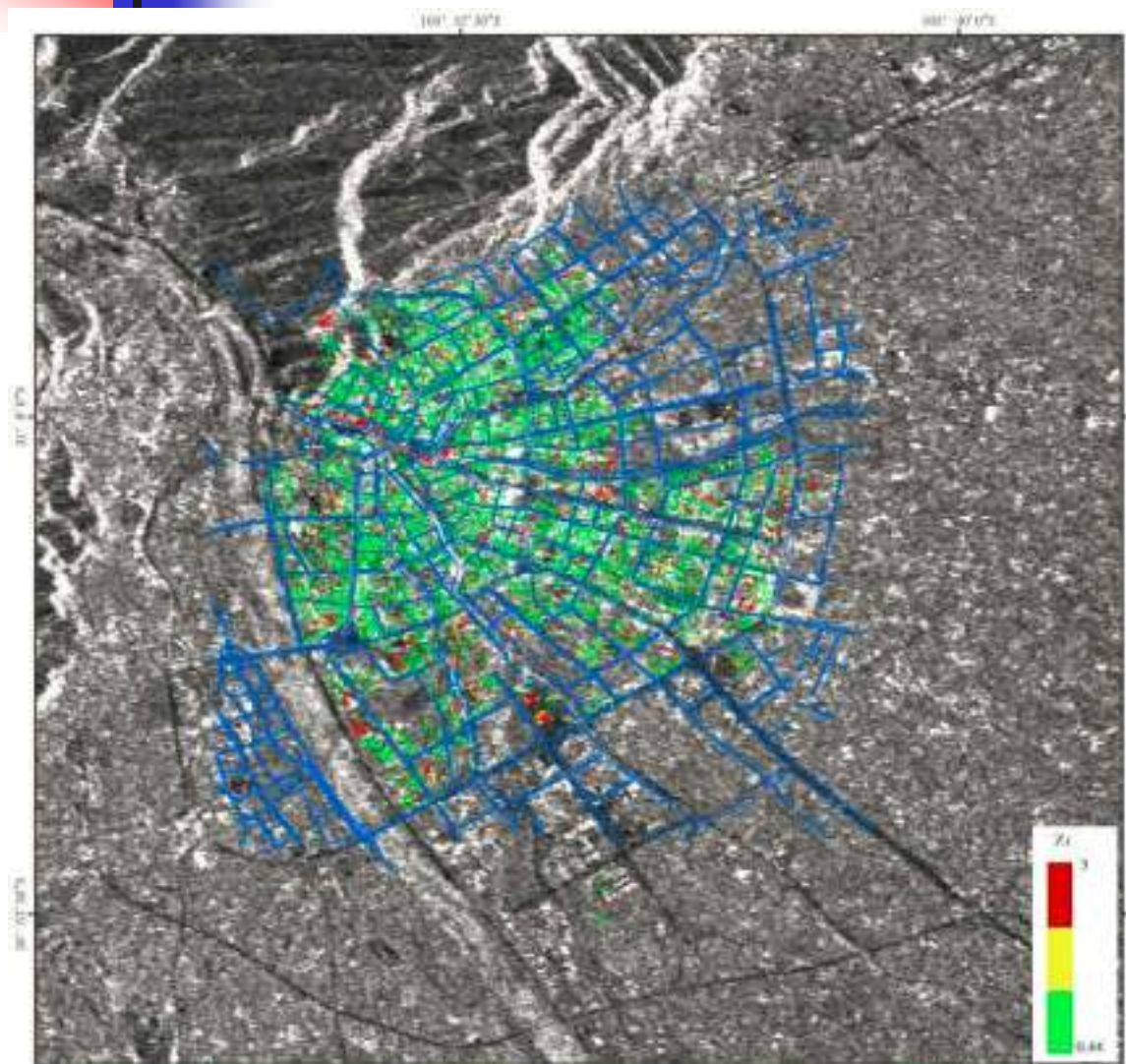




Accuracy

Category	accuracy%	ignorance%	Missing%
Intact	70.6	29.4	15.5
Medium	88.8	11.2	79
Collapsed	69.4	30.6	16.2
Overall	70.74%		

Synectic Texture Correlation and Difference



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Accuracy

Category	Accuracy%	Ignorance/%	Missing/%
Intact	79.26	20.7	12.2
Medium	79.9	20	78.6
Collapsed	82.2	17.8	12.8
Overall	79.2%		



Limitation

- Same geometry, same incidence angle for prior and post event
- Training data set requirement, if no training data, accuracy less than 60%,



Only one PolSAR data post earthquake

- A lot of researches by using SAR amplitude and phase information, but PolSAR not yet fully studied
- Although CHARTER, SAR post earthquake acquisition improved much, including PolSAR, but PolSAR achieved prior earthquake is still not yet universally available, eg. Chile, New Zealand, Mexico,
- PolSAR is sensitive to structure of building, direction
- Unique mechanism

POLARIMETRIC SAR SENSORS

AIRBORNE SENSORS



AES1
AeroSensing (D)



AIRSAR
NASA / JPL (USA)



DOSAR
EADS / Domier GmbH (D)



ESAR
DLR (D)



EMISAR
DCRS (DK)



MEMPHIS / AER II-PAMIR
FGAN (D)



PHARUS
TNO - FEL (NL)



PISAR
NASDA / CRL (J)



RAMSES
ONERA (F)



RENE
UVSQ / CETP (F)



STORM
UVSQ / CETP (F)



SAR580
Environnement Canada (CA)

SHUTTLE / SPACEBORNE SENSORS



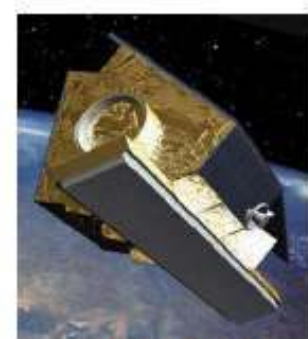
SIR-C
NASA / JPL (USA)



ENVISAT / ASAR
ESA (EU)



ALOS / PALSAR
NASDA / JAROS (J)



TERRASAR
BMBF / DLR / ASTRIUM



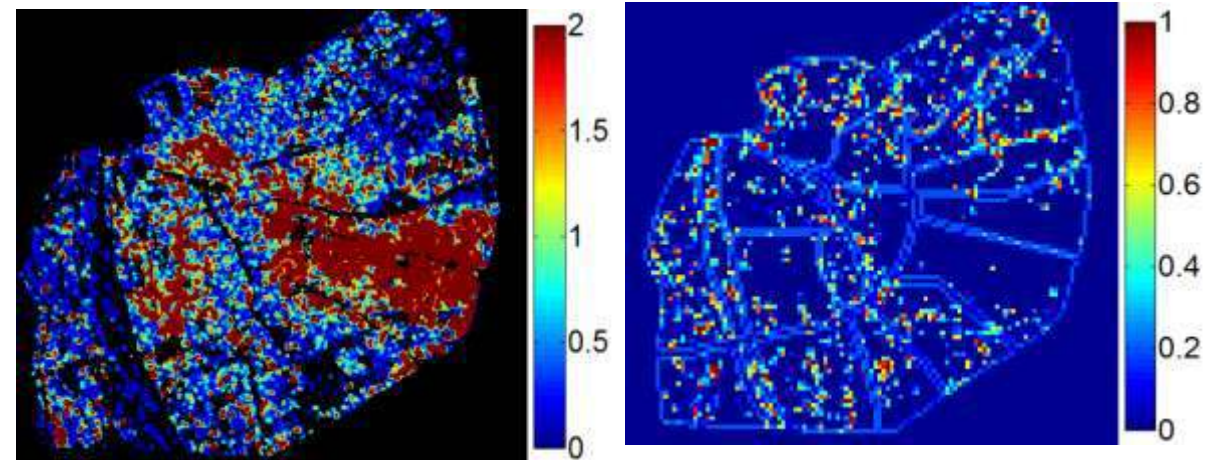
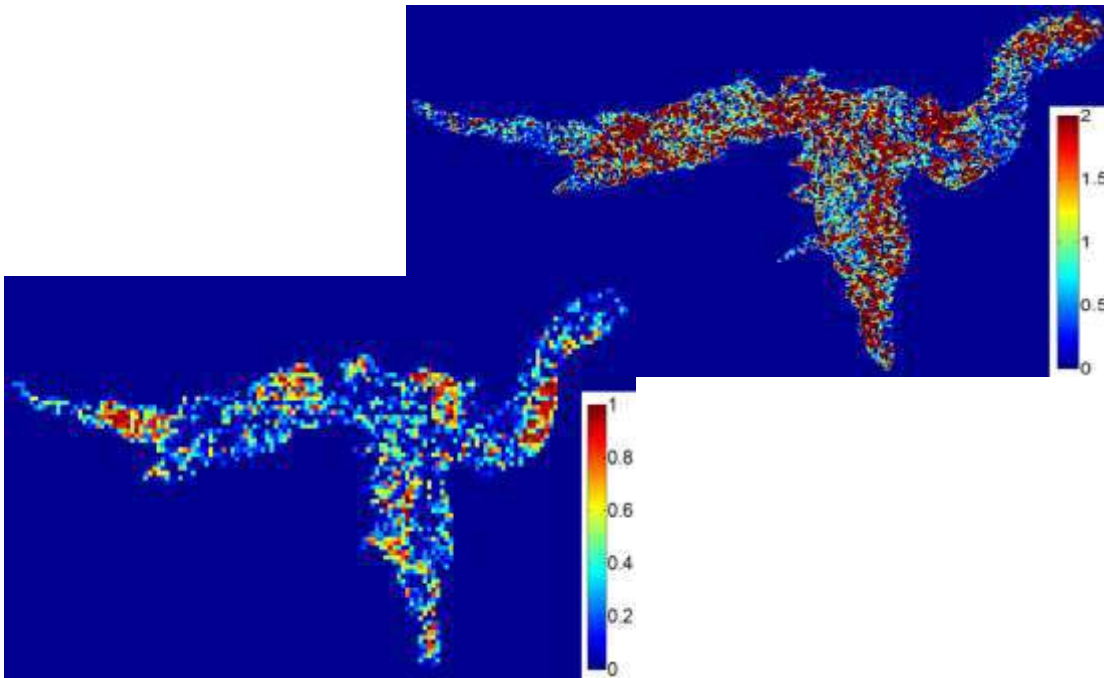
RADARSAT 2
CSA - MDA (CA)

Radar Remote Sensing Damage Index, RRSDI (Dr. Qing Wang)

- Polarmetric decomposition, double bounce and volume scattering decrease, single scattering increase
- Yushu Earthquake & Dujiangyan
- R2

$$RRSDI = \frac{K}{(1-K)} \cdot \frac{f_d + f_h + f_v}{(f_s + f_v)}$$

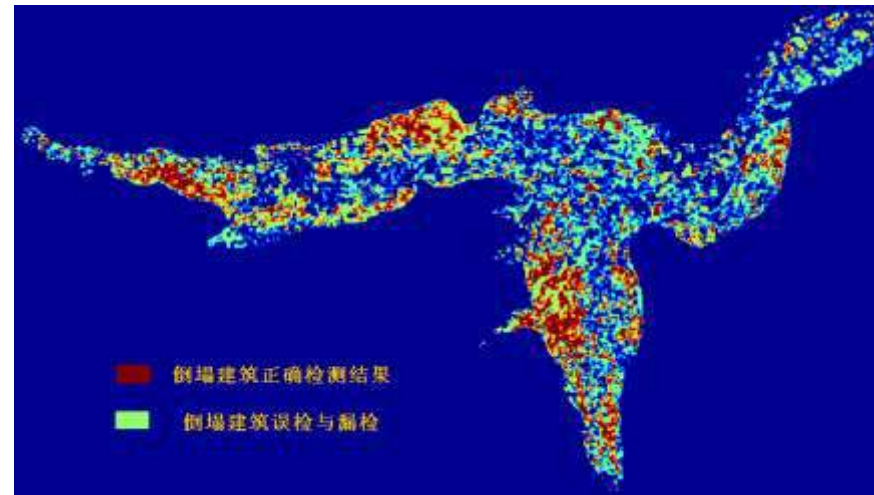
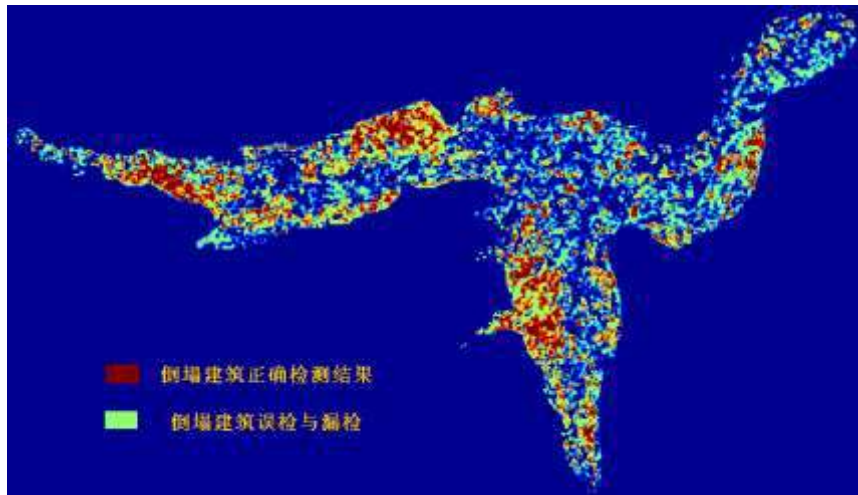
$$K = |\rho_{RRLL}|$$



Optimum of Polarmetric Contrast Enhancement (OPCE) (Dr. Qing Wang)



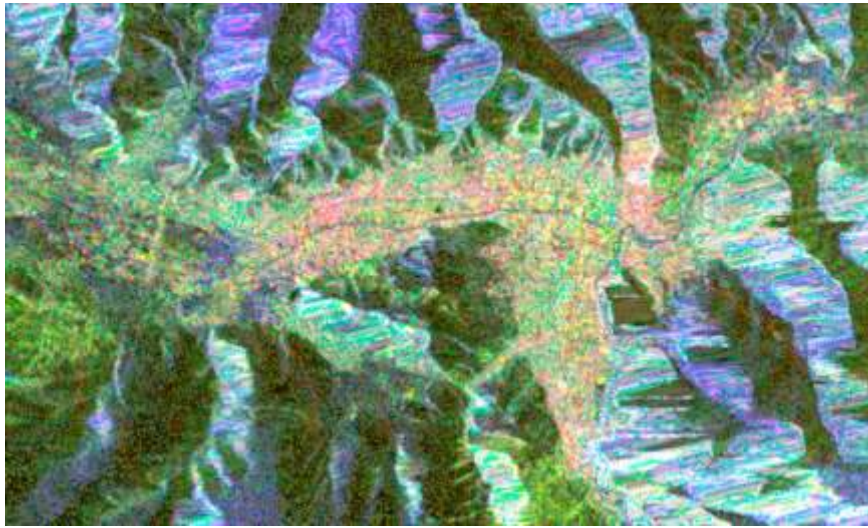
	正确检测率	错误检测率	漏检率
理想散射模型	65.4%	34.6%	37.6%
真实散射模型	73.5%	26.5%	29.5%



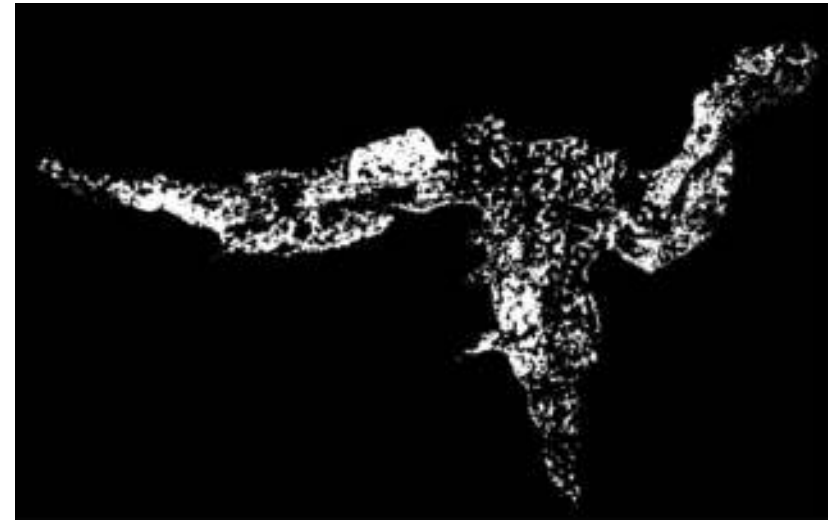


Generalized OPCE (Dr. Haizhen Zhang)

Yushu Earthquake



Pauli



Extracted Collapsed building

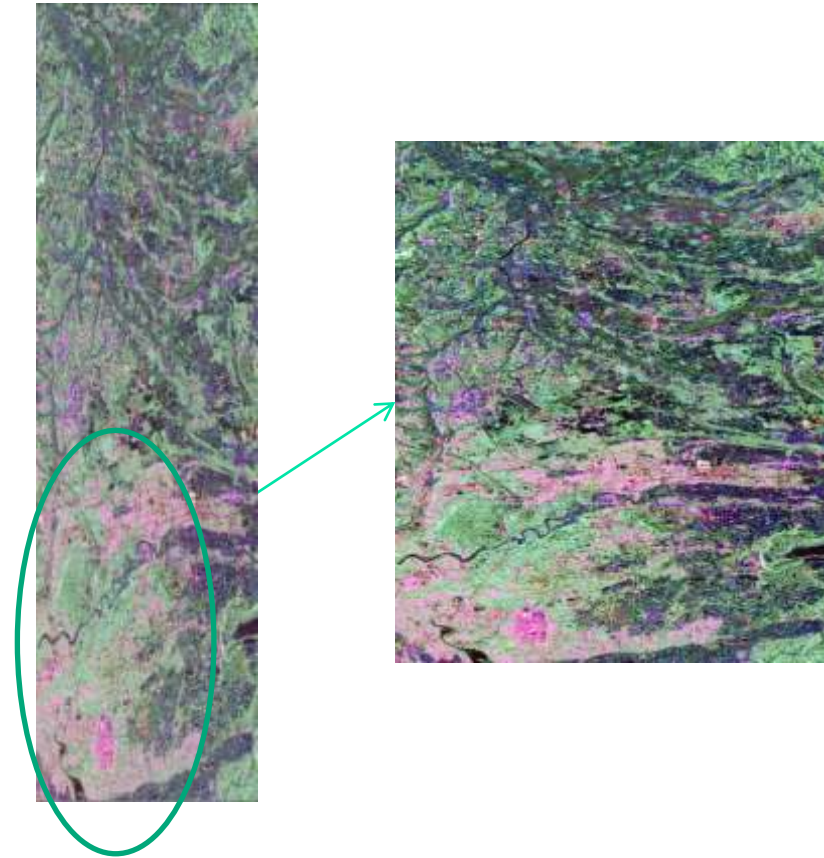
Accuracy :64.19%, Missing: 34.72%

OPCE for Kumamoto Earthquake (Dr. Haizhen Zhang)

- Data: ALOS PALSAR PolSAR , 2016年4月21日
Beijing 2, post the quake

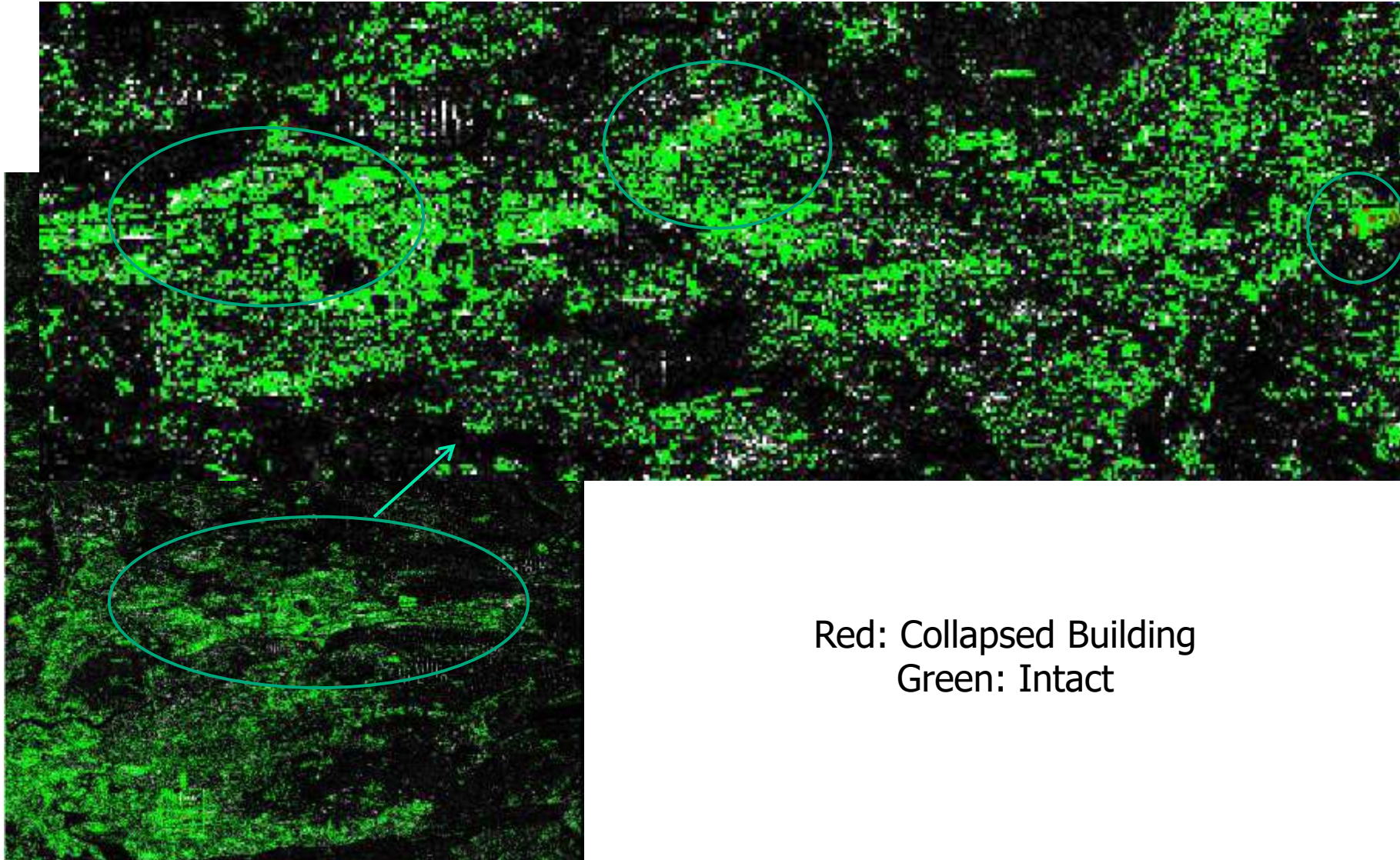


极化SAR数据与光学数据地理范围

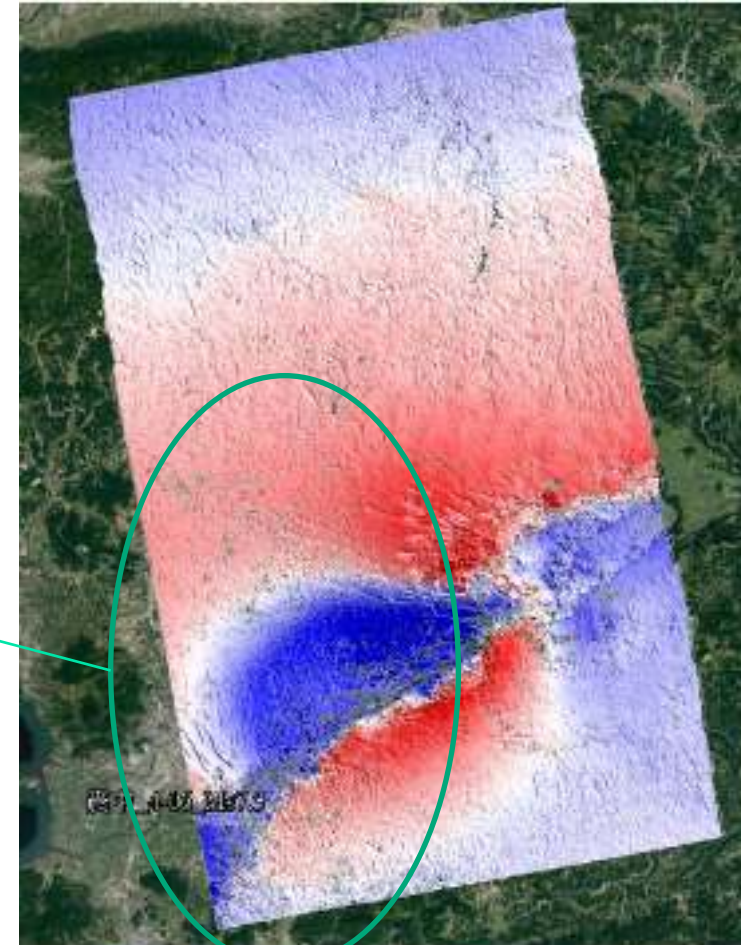
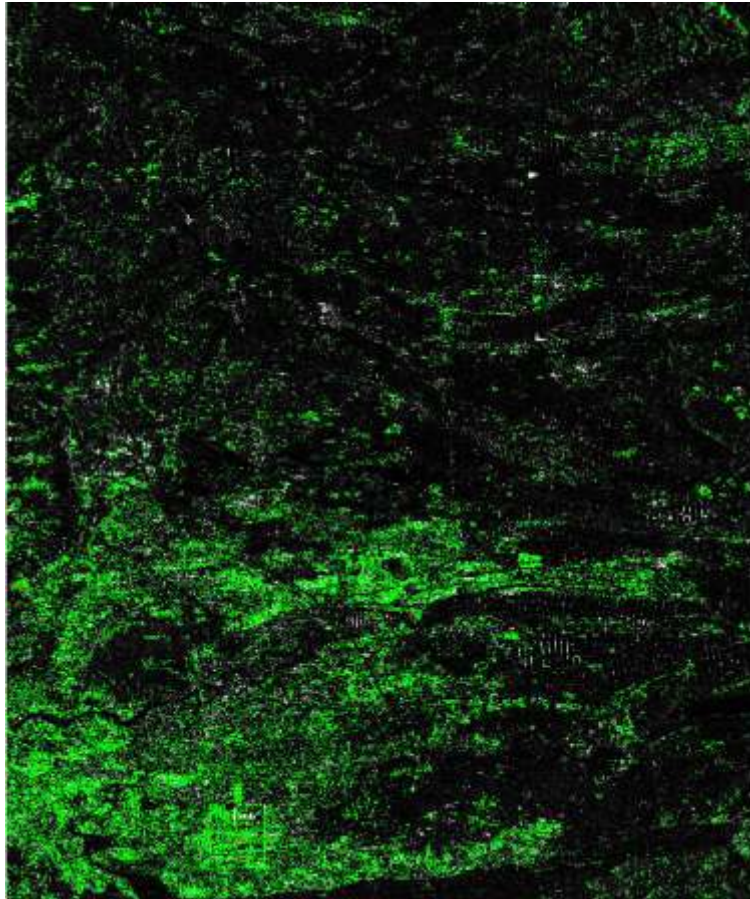


ALOS-2 熊本地区Pauli图及研究区范围

OPCE, Kumamoto



OPCE, Kumamoto



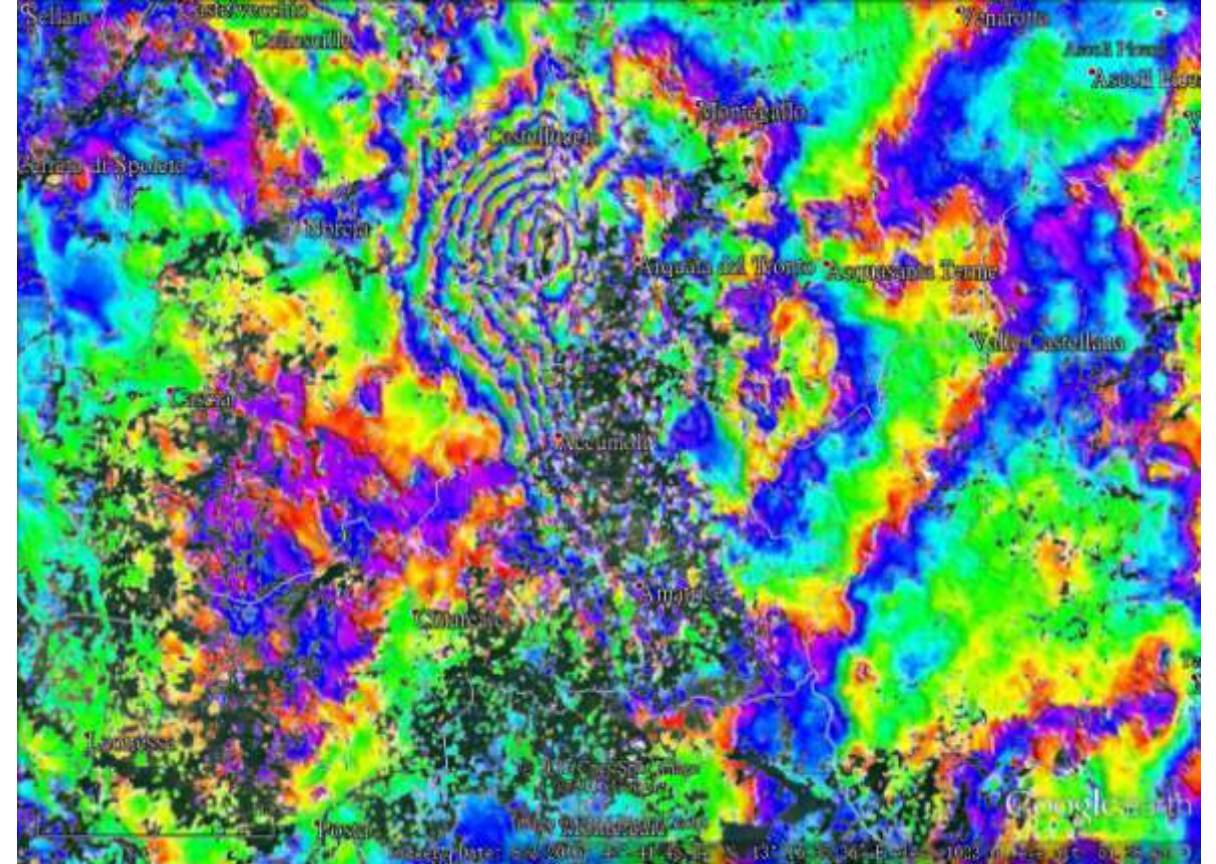
Comparison with InSAR

-369.2 -184.6 0.0 184.6 range decrease
LOS displacement, mm

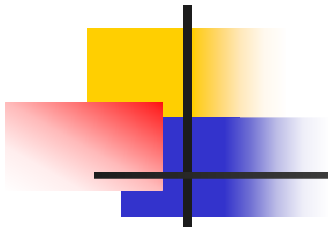
Italy Earthquake (Mr. Asset)



BJ2 post the quake



Sentinel1-A InSAR

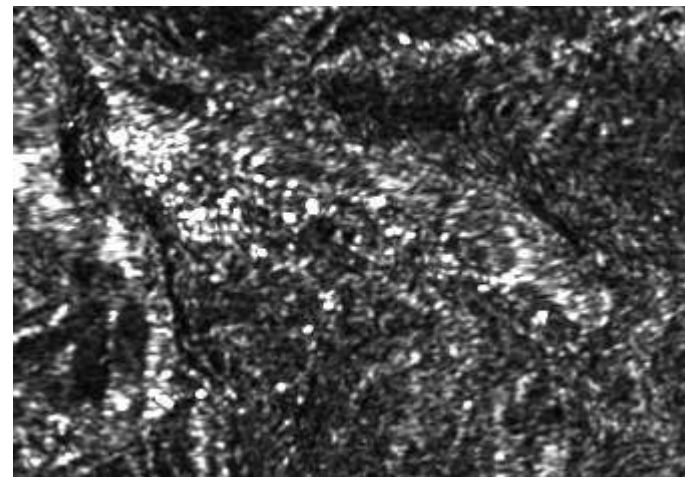
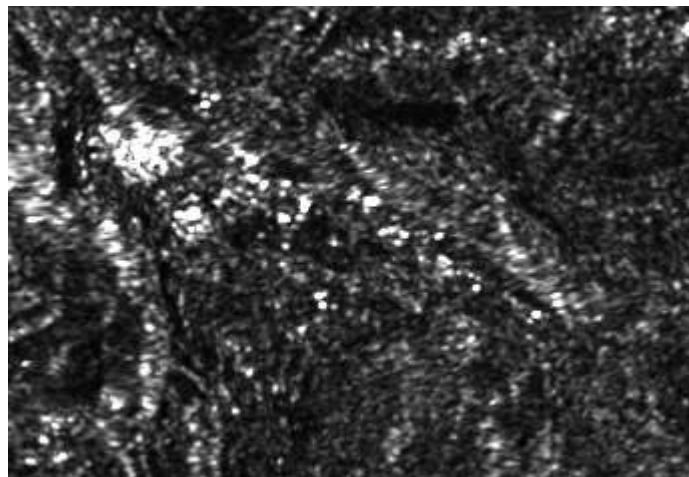


Change Detection by using dual Pol S1

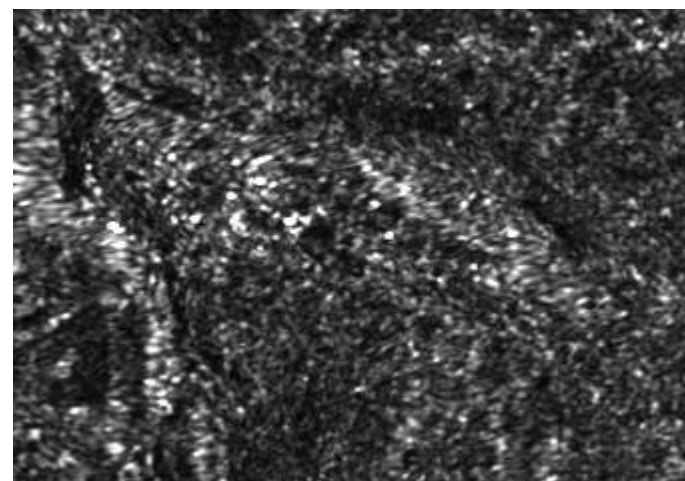
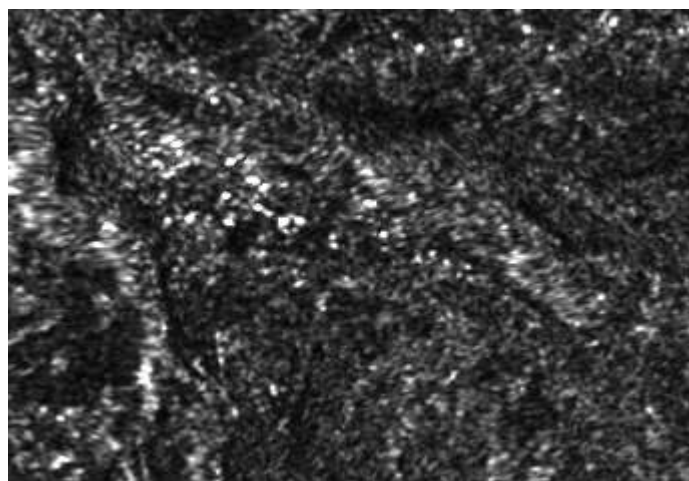
Pre-

Post

VV sigma0



VH sigma0





Conclusion

- Accuracy not yet satisfied
- Building diversity (structure, direction)
- Resolution
- Data available