Application of Polarimetric SAR to rice field observation

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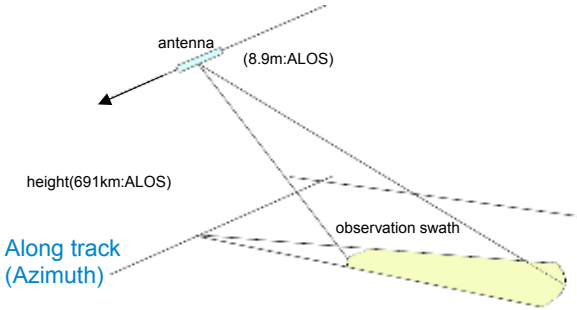
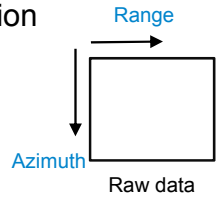
Synthetic Aperture Radar

Synthetic Aperture Radar (SAR)



・active microwave sensor
cloud free, day-and-night land observation
・side looking radar
・resolution: ~ 7m (ALOS PALSAR)
~1m (TerraSAR-X)



Development History of SAR

1904	Prototype Radar
1940's	Progressive development by World War II
1950's	Real Aperture Radar
	~Synthetic Aperture Radar （military secrecy）
1967	Airborne SAR (geology of Amazon area)
1978	First Spaceborne SAR（SEASAT）
1981	SIR-A (Shuttleborne SAR）
1983	Spaceborne SAR（KOSMOS: Soviet Union）
1984	SIR-B
1991	ERS-1 (-2000:ESA)
1992	JERS-1 (-1998:Japan)
1994	SIR-C
1995	ERS-2(- :ESA),RADARSAT
1997	Pi-SAR (Japan)
2000 2	SRTM(Shuttle Radar Topography Mission)
2002 3	ENVISAT/ASAR (ESA)
2003	Information Gathering Satellite (Japan)
2006 1	ALOS/PALSAR (-2011: Japan)
2007 6	TerraSAR-X (Germany)
	COSMO-SkyMed-1 (Italy)
2007 12	RADARSAT-2 (- : CANADA)
2010 8	TanDEM-X (Germany)

Satellite borne SAR (1990's～)

ERS-1	C-band	VV	(1991-2000:ESA)
ERS-2	C-band	VV	(1995 - :ESA)
JERS-1	L-band	HH	(1992-1998:JAPAN)
RADARSAT	C-band	HH	(1995- :CANADA)
RADARSAT-2	C-band	HH,HV,VV,VH	(2007- :CANADA)
ENVISAT/ASAR	C-band	HH/HV	(2002- :ESA)
Information Gathering Satellite -1B			(2003-2007:JAPAN)
	-2B		(2003 :JAPAN)
	-4B		(2007-2010 :JAPAN)
ALOS/PALSAR	L-band	HH,HV,VV,VH	(2006-2011: JAPAN)
TerraSAR-X	X-band	HH/HV, VV/VH,HH/VV	(2007- :Germany)
TanDEM-X	X-band	HH/HV, VV/VH,HH/VV	(2010- :Germany)
COSMO-SkyMed-1	X-band	HH,HV,VV,VH	(2007- :Italy)
-2	X-band		(2007- :Italy)
-3	X-band		(2008- :Italy)
-4	X-band		(2010- :Italy)
ALOS-2			*(2013? JAPAN)*

Application of SAR data

■Backscattering characteristics:

Land surface: forest, agriculture, urban structure, geology, glacier, polar region, disaster monitoring, water content, snow cover, soil moisture,,,,

Sea surface: oil spill, sea wind,,,,

■Interferometric SAR:

Crustal deformation detection (earthquake, volcanic activity, land subsidence)

DEM generation

Building collapse (coherence)

■Polarimetric SAR:

Land surface: forest, agriculture, urban structure, geology, disaster monitoring,,,

■Interferometric Polarimetric SAR:

Vegetation height

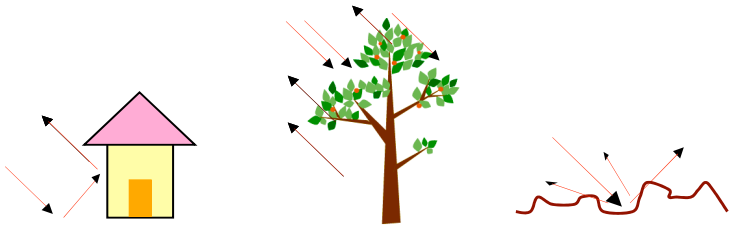
Polarimetric SAR

Horizontal and Vertical Polarization

Pi-SAR Antenna

Polarimetric Decomposition

~three component decomposition~



Theoretical scattering model

(Freeman and Durden (1998))

Polarimetric Decomposition

~ *H-A-α* decomposition ~

- ✶Entropy

  randomness of the scattering

- ✶Anisotropy

  relative scattering of the second and the third eigenvalues

- ✶Alpha

  indicator of the type of scattering mechanism

0° :plane　　45° :dipole　　90° :corner reflector

(Cloude and Pottier (1996, 1997))

POLARIMETRIC OBSERVATION FOR RICE FIELD BY RADARSAT-2 AND ALOS/PALSAR

Introduction

Rice Field Monitoring by Space-borne Full Polarimetric SAR

Full Polarimetric SAR
:scattering characteristics

ALOS PALSAR	L-band
RADARSAT-2	C-band

- Three component decomposition
- H-A-α decomposition

ALOS PALSAR

★Three component decomposition:
Main scattering component of rice field
:Grain filling season - Double bounce scattering
:Harvested ~ Transplanting season - Surface scattering

★*H-A-α* decomposition:
Alpha angle
-relationship with rice filed condition

RADARSAT-2

Test Site

- Paddy Field
- Paddy field (whole crop rice)
- Soy bean field
- Grass land

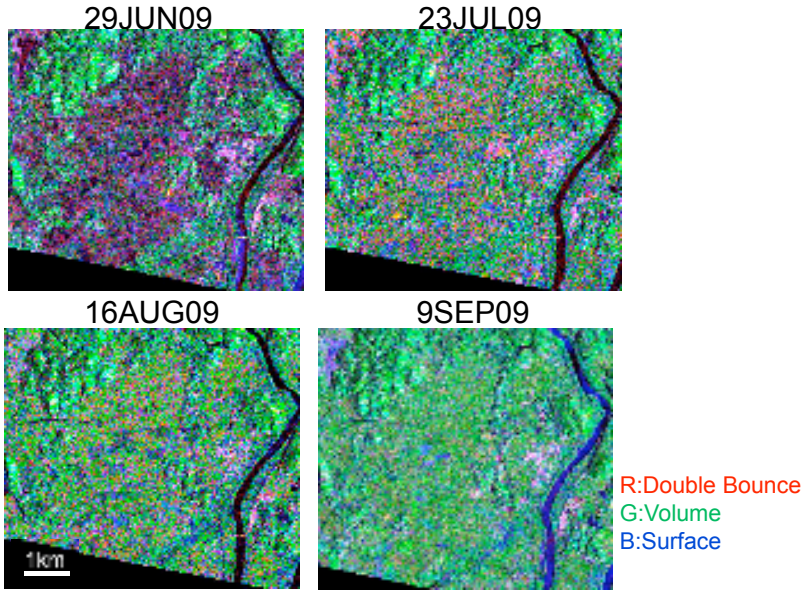
RADARSAT-2
Data

Full Polarization
Fine QP (incidence angle 20.1° Des.) resolution: 11×9m

29-Jun-09
23-Jul-09
16-Aug-09
9-Sep-09

RADARSAT-2

Three Component Decomposition



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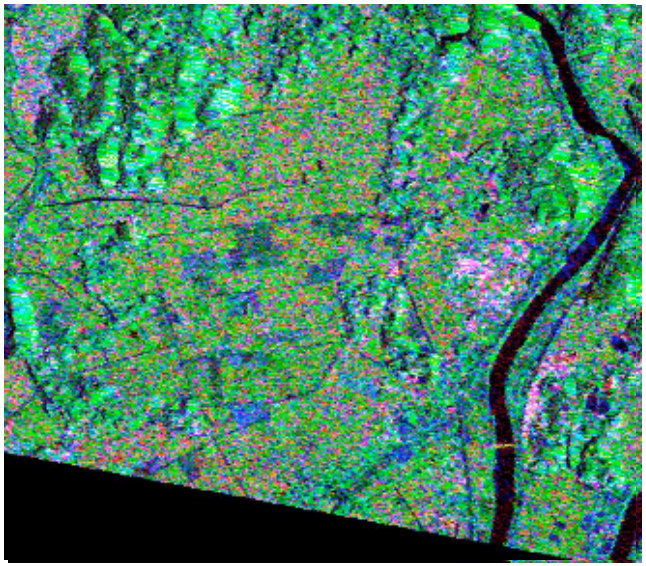
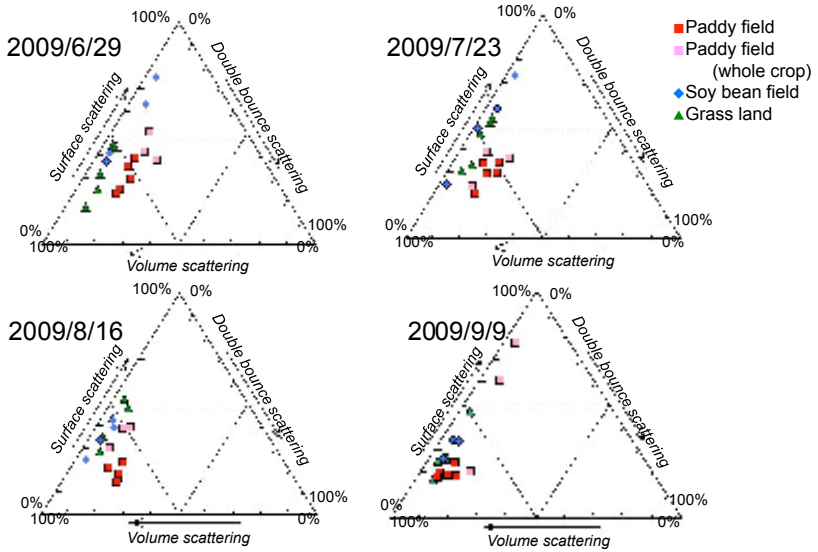


Three component decomposition



Summary

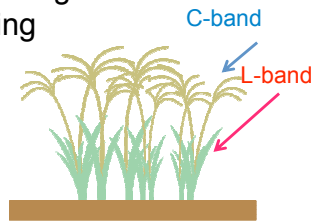
★Main scattering component for grain filing season on three component decomposition:

PALSAR (L-band): double bounce scattering

RADARSAT-2(C-band): volume scattering

⇒scattering mechanism difference

L-band transmit paddy rice field



★ *H-A-α* decomposition

PALSAR, RADARSAT-2:

Entropy: 0.5~0.6 Alpha: 40 ~ 50 ° Anisotropy: 0.6~0.7

★ Possibility of rice growth monitoring

RADARSAT-2 : increase of volume scattering ratio

continuous observation on rice growing season is necessary to discuss the possibility for L-band SAR

References

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理工図書 (2011)

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http://earth.eo.esa.int/polsarpro/default.html
Polarimetric analysis tool

★Alaska Satellite Facility
http://www.asf.alaska.edu/
MapReady: Geocoding tool