→ 3rd ADVANCED COURSE ON RADAR POLARIMETRY

Advanced Land Observing Satellite-2 (ALOS-2) and PALSAR-2

- Performance and the calibration -

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- ALOS-2/PALSAR-2
- Mission objectives
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- Science and Application
  - Deformation measurement using DinSAR
  - Polarimetry
  - Forest Observation
  - Sea Ice (ship Detection)
- BOS
- Data Utilization site
- Conclusions

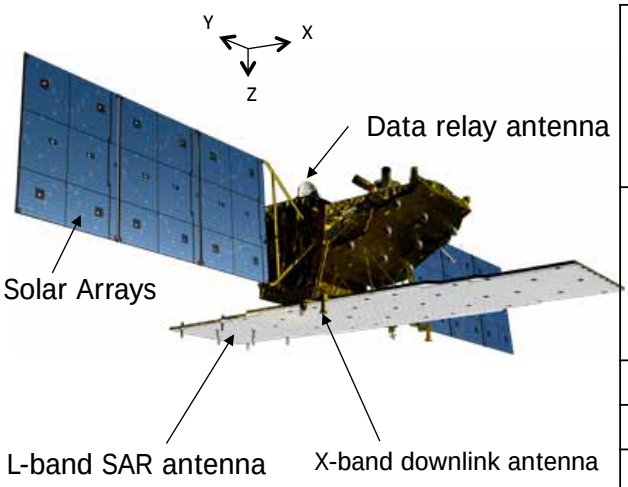
ALOS-2 and PALSAR-2

- Information of the hardware and the missions

2014年5月24日，12時05分

ALOS-2 satellite

ALOS-2 in-orbit configuration



Specification

L-band SAR (PALSAR-2)	Stripmap: 3 to 10m res., 50 to 70 km swath ScanSAR: 100m res., 350km/490km swath Spotlight: 1×3m res., 25km swath
Orbit	Sun-synchronous orbit Altitude: 628km Local sun time : 12:00 +/- 15min Revisit: 14days Orbit control: ≦+/-500m
Life time	5 years (target: 7 years)
Launch	May 24, 2014, H-IIA launch vehicle
Downlink	X-band: 800Mbps(16QAM) 400/200Mbps(QPSK) Ka-band: 278Mbps (Data Relay)

Experimental	Compact InfraRed Camera (CIRC) SPace based Automatic Identification System Experiment(SPAISE2)

ALOS-2 Schedule

ALOS-2 is in good condition and the everything is on-going.

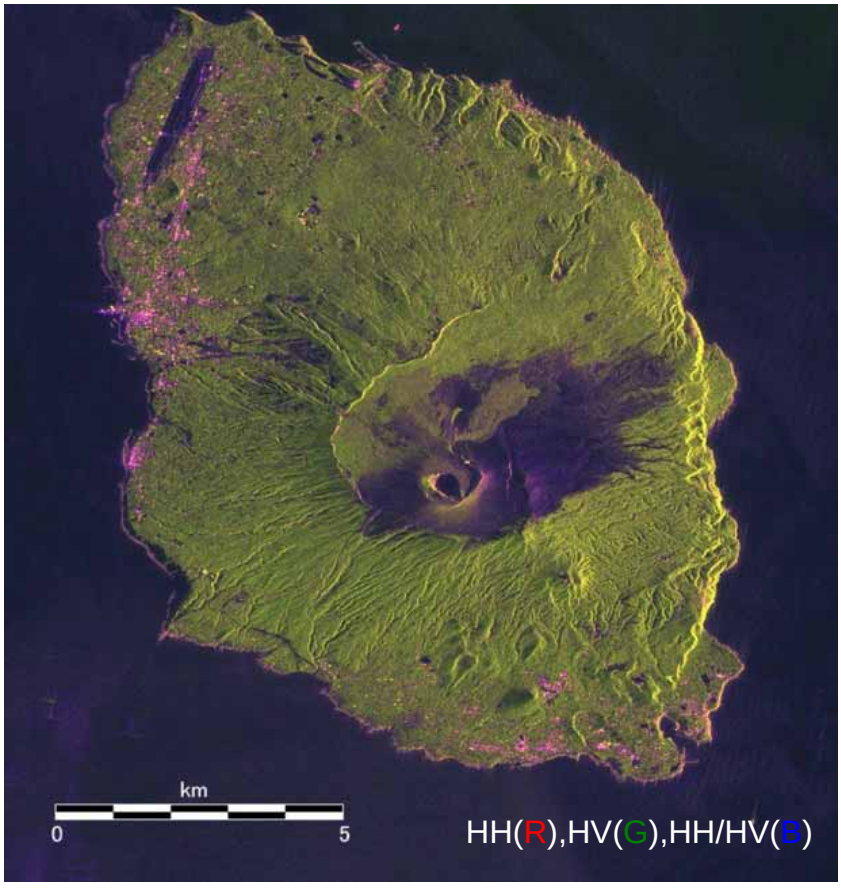
- May 24-26 launched and PALSAR-2 antenna deployed.
- June 19-21 PALSAR-2 first images were acquired.
- June 27 PALSAR-2 first images were released.
- Aug. 4 Initial Calibration started
- Aug. 20 Move to the operational observation phase。
- Nov. 25 starts the product distribution

ALOS-2 Mission Objectives

- Disaster Monitoring (including the solid earth research-Polarimetry application)
- Environmental monitoring for Biosphere, Geosphere, Cryosphere, and Hydrosphere
- Natural Resources (Agriculture, Ocean monitoring, and Resources)
- Technology Development for the Future Earth Remote sensing (satellite and sensor)

Izu Island image of the PALSAR-2 First Image on June 19 2014

3m Strip mode (84 MHz) dual Pol.



PALSAR-2 mode and specifications

Mode		Spotlight (S)	Ultra Fine (U)	High Sensitive (H)	Fine (F)	ScanSAR Nominal (W)		ScanSAR Wide (V)
Bandwidth		84MHz	84MHz	42MHz	28MHz	14MHz	28MHz	14MHz
Resolution		Rg×Az: 3×1m	3m	6m	10m	100m(3 looks)		60m(1.5 looks)
Swath		Rg×Az: 25×25km	50km	50km	70km	350km 5scan		490km 7scan
Polarization		SP	SP/DP	SP/DP/FP/CP		SP/DP		
NESZ		-24dB	-24dB	-28dB	-26dB	-26dB	-23dB	-23dB
S/A	Rg	25dB	25dB	23dB	25dB	25dB		20dB
	Az	20dB	25dB	20dB	23dB	20dB		20dB
REC		D	D	D	S	D		D
DC		B4	DB4||DB2	B4||DB4	B4||DB4	B4		B4

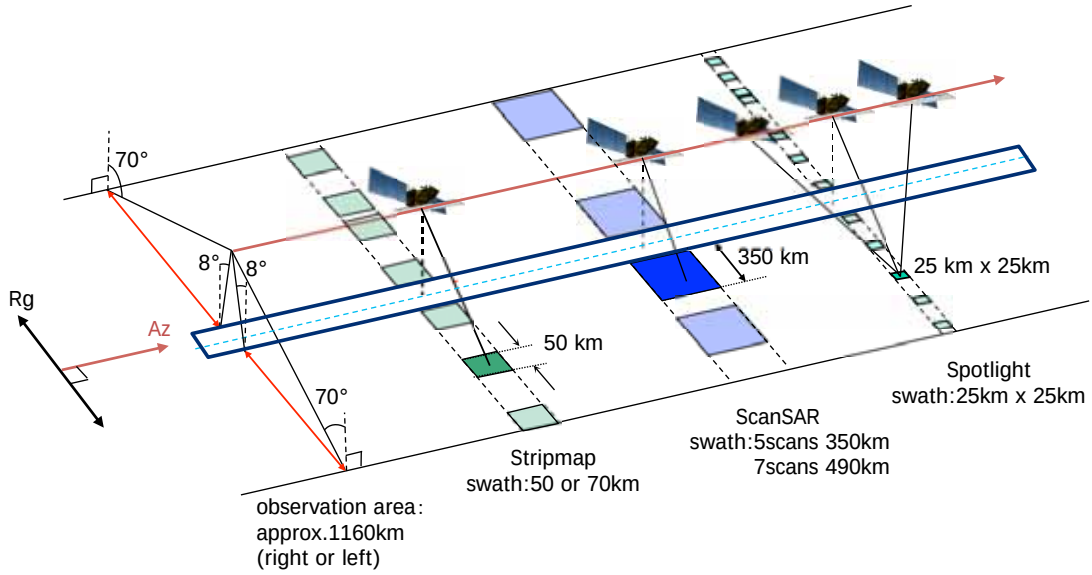
SP : HH or VV or HV , DP : HH+HV or VV+VH , FP : HH+HV+VH+VV , CP : Compact pol (Experimental mode)
REC: Number of receivers（受信機数：D:Dual, S: Single), DC:Data Compression, DB4:DS-BAQ4,B4:BAQ4

Spotlight (S): **Detail observation of damaged area**
Ultra Fine(U): **High Resolution (Japan area baseline)**
High sensitive(H): **Flood / Coast monitoring**
Fine(F): **Global observation (deformation/forest)**
ScanSAR nominal(W): **ScanSAR InSAR (28MHz)**
ScanSAR wide(V): **Ice monitoring, Ship detection**

Four new techniques

- **High power and efficiency device**
  - GaN HEMT, the first flight for satellite in the world, for lower NESZ (37.1 W/TRM)
- **Dual receive antenna system**
  - wider swath with lower PRF
  - Five electric panels are in full aperture for transmission and are divided for receiving
- **Chirp modulation (+Azimuth Phase coding)**
  - Up/Down and Phase modulation for higher SA
- **New data compression**
  - updated BAQ algorithm

PALSAR-2 imaging mode

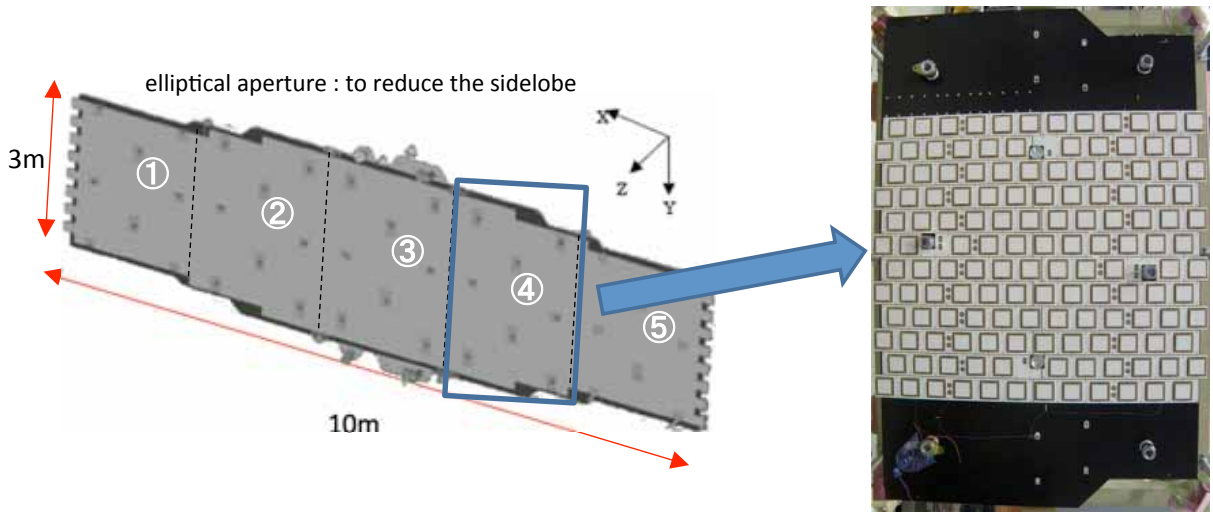


Observable area :

Right or left-looking by spacecraft maneuvering at 30 degrees off-nadir with electric beam steering using active phased array antenna (incidence angle from 8 to 70 degrees).

The Engineering Models

- The antenna Engineering Model (EM)
  - the size for antenna EM is half of one electric panel.

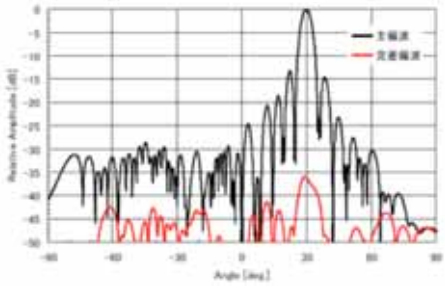


The structure is one electric panel size,
however the only half quantity of antenna radiation elements are mounted.

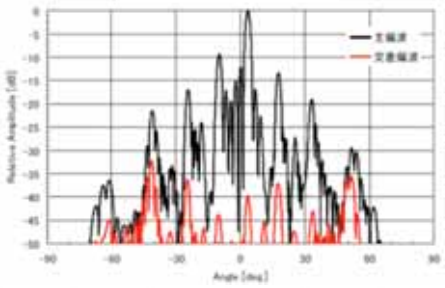
The Engineering Models

- The interface between antenna elements and the components mounted on antenna was confirmed.
  - mounted components are transmission and receive module(TRM), power supply for TRM(MPSU) and control unit (CDU) etc.
- The analyzed radiation antenna pattern using EM of antenna elements was good result,

EL 30deg stterubg

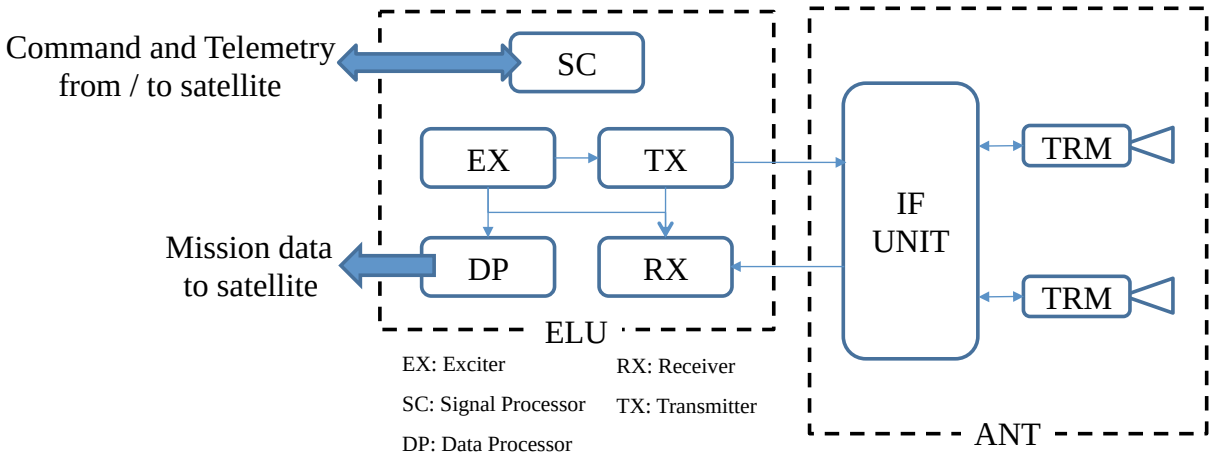


Az 3.5 deg stterubg

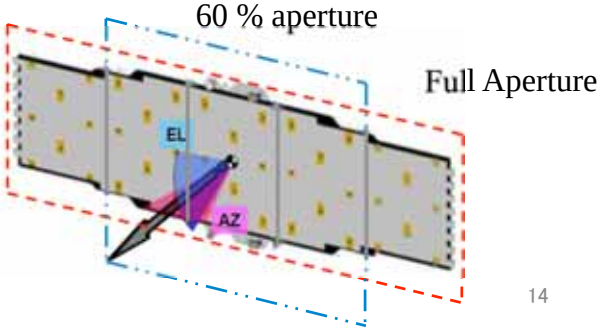


- The realistic radiation antenna pattern (antenna EM size) will be measured in this week.

2. Technical overview of PALSAR-2



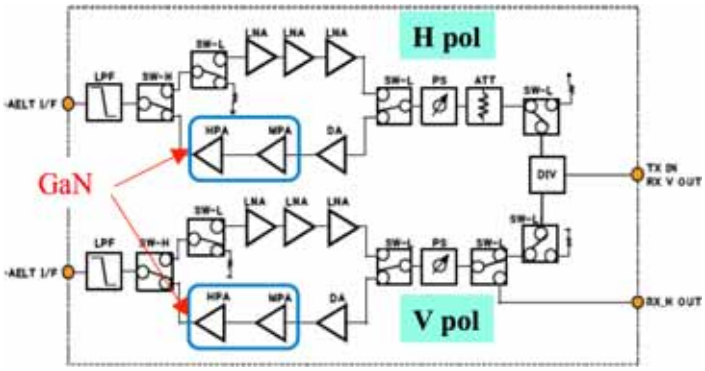
Transmitting Aperture
Spotlight/Ultra-Fine : 60 % aperture
Others : Full Aperture



2. Technical overview of PALSAR-2

Transmitting and Receiving Modules (TRMs)

- Control the polarization independent
- High power, high efficiency and downsizing

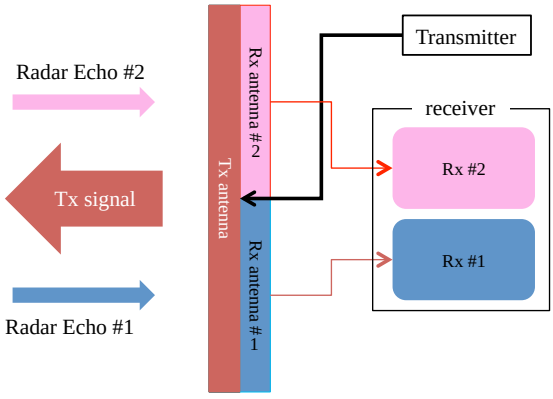


	PALSAR-2	PALSAR
HPA	GaN HEMT	Si BJT
Tx power	34W	25W
Units	180	80
Efficiency	35%	25%
Noise Figure	2.9dB	2.9dB
TRM size[mm]	200×110×14.6	203×117×23.5
TRM weight	400g	675g

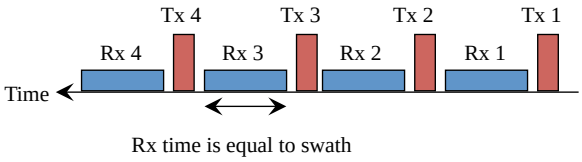
Downsizing and high efficiency

2. Technical overview of PALSAR-2

Dual receiving antenna system

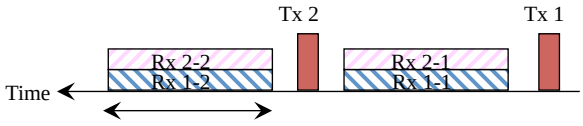


- Single beam technique overview



Rx time is equal to swath

- Dual beam technique overview



Single beam : Fine mode
Dual beam for other modes

受信1と受信2を組合せて処理することで、1つの長い受信波と等価になる。その結果、受信時間が2倍になるため、2倍の観測幅が実現可能

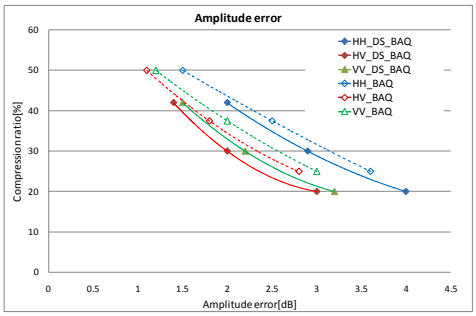
2. Technical overview of PALSAR-2

Data compressoin

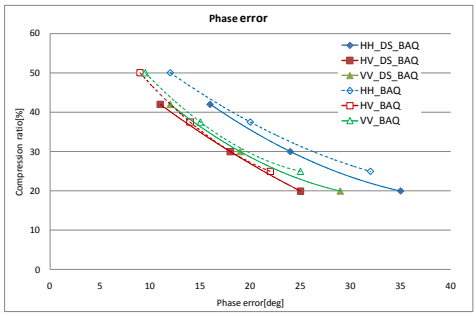
•selectable DS-BAQ (Down-Sampling BAQ) or BAQ

PALSAR : 3bit cut off (8bit ⇒ 5bit)
Other SAR satellite : BAQ（Block Adaptive Quantization）

“ Down sampling” is to cut off the out of band of radar bandwidth at A/D conversion



amplitude error



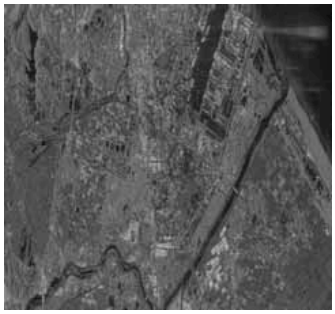
Phase error

the compressed data quality is higher than BAQ

2. Technical overview of PALSAR-2

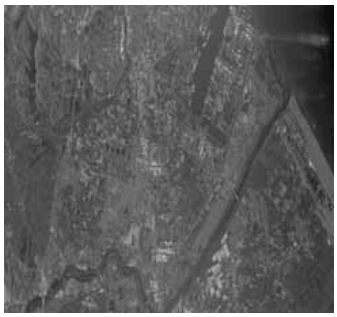
The simulation of DS-BAQ compression

Original data

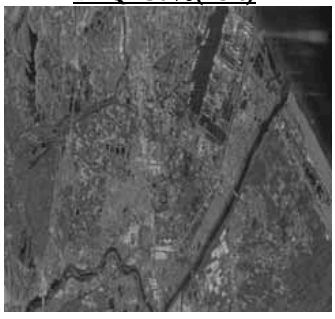


DS-BAQ 40%(4bit)

DS-BAQ 20%(2bit)



BAQ 50%(4bit)



BAQ 25%(2bit)

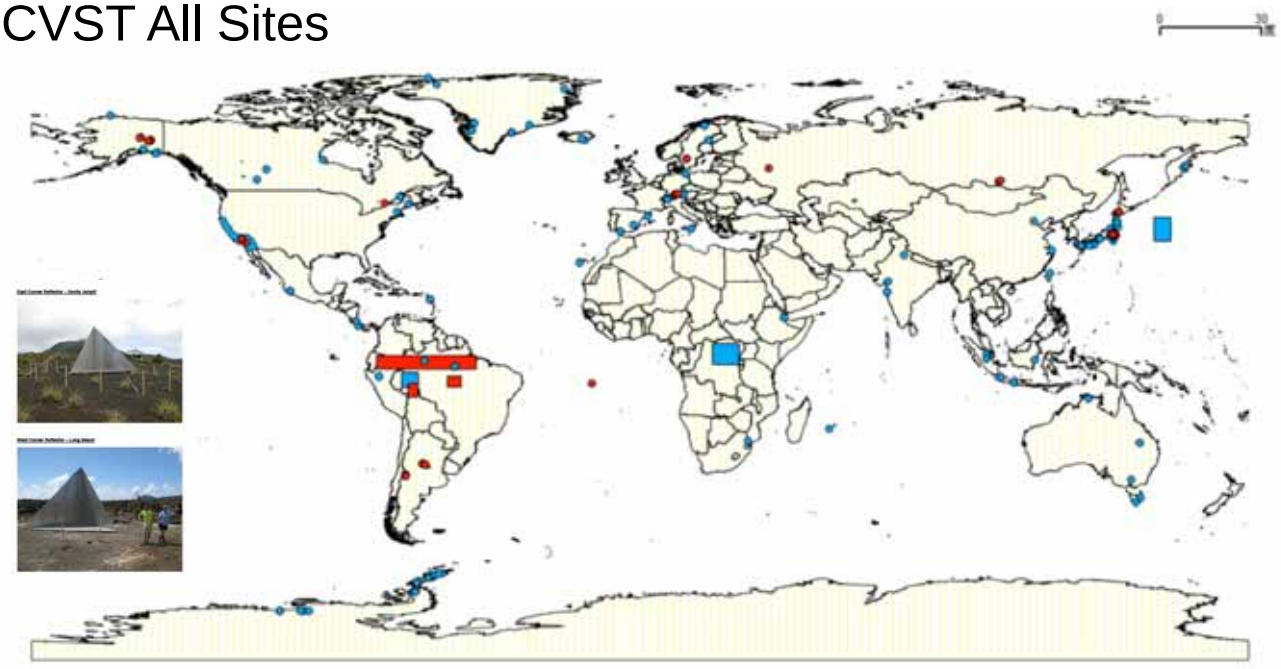
There is no difference between DS-BAQ and BAQ.
The data rate compressed by DS-BAQ is lower than BAQ.

PALSAR-2 Calibration

- Raw data evaluation
- SAR Processor
- Antenna Pattern Evaluation
- Polarimetric Calibration
- Image Quality

3.3.1 Global distribution of the calibration site）(5/12)

CVST All Sites



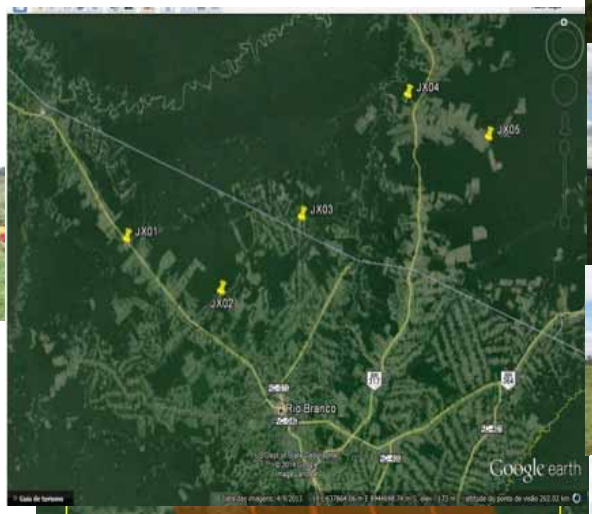
Red circle and square indicates CR sites (including JAXA Cal sites)

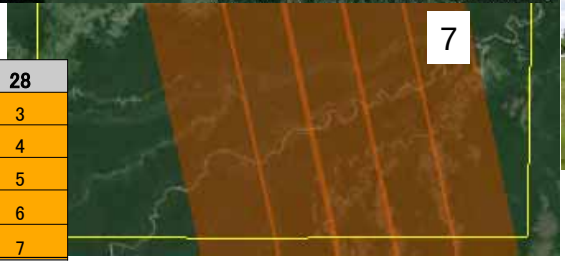
3.3.1 校正検証（苫小牧サイト状況）(7/12)

3.3.1 Polarimetric Calibration in Brazil site

左上： -8.0°-68.65°
右下：-12.0°-65.75°

Beam3 cycle6
Beam4 cycle7
Beam5 cycle8
Beam6 cycle9
Beam7 cycle10





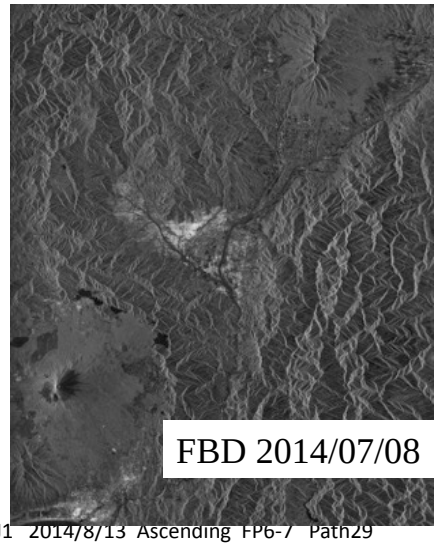
RioBranco

Cycle	Site Name	Area	Mode	28
Cycle 6	RioBranco	S02	HBQ	3
Cycle 7	RioBranco	S02	HBQ	4
Cycle 8	Rio_Branco	S02	HBQ	5
Cycle 9	RioBranco	S02	HBQ	6
Cycle 10	RioBranco	S02	HBQ	7

PALSAR-2 Images (UB, HB, FB)

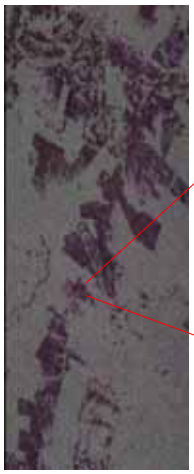
Strip mode（UB, HB, FB）

UB：Quebec(2014/06/20)



FBD 2014/07/08

J1 2014/8/13 Ascending FP6-7 Path29



Site1

HBQ-RioBranco

PALSAR-2 Images (Spotlight and Ultra Fine)

A

SB

@JAXA Produced by @RESTEC

SB

UB

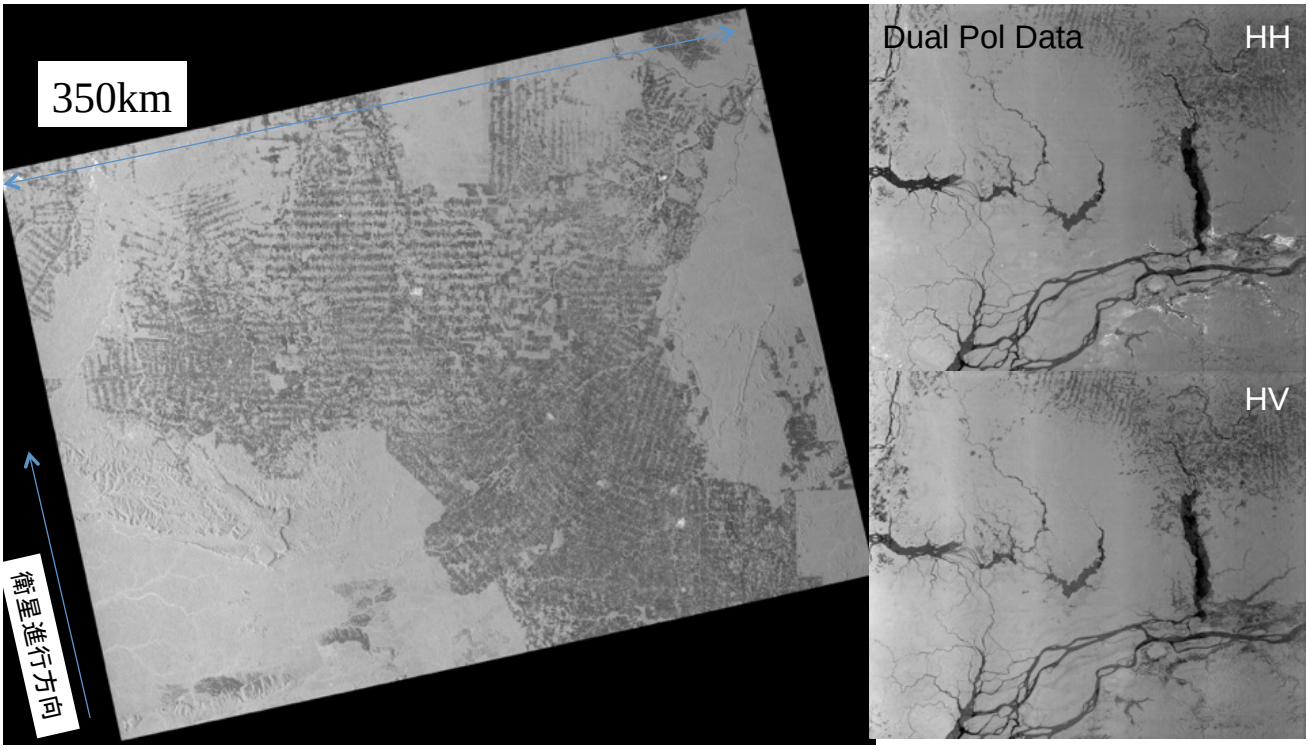
PALSAR-2 Images (Spotlight and Ultra Fine)

SB　　UB(3m)

PALSAR-2 Images (ScanSAR)

ScanSAR：Amazon Rondonia area (HH)

Area: Amazon Rondonia
Date: July 20, 2014
Bandwidth: 28 MHz
Mode：W2



Comparison in HH

PALSAR-2
（June 2014）

Pi-SAR-L2
（Oct. 2013）

Comparison in HV

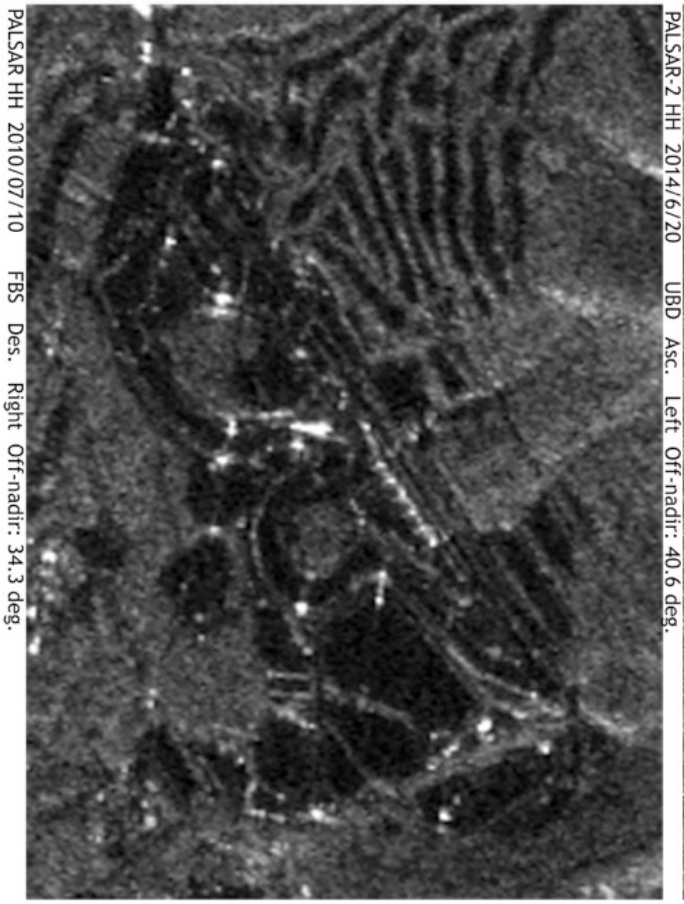
PALSAR-2
（June 2014）

Pi-SAR-L2
（Oct. 2013）

Fuji Speedway car circuit

PALSAR

PALSAR-2



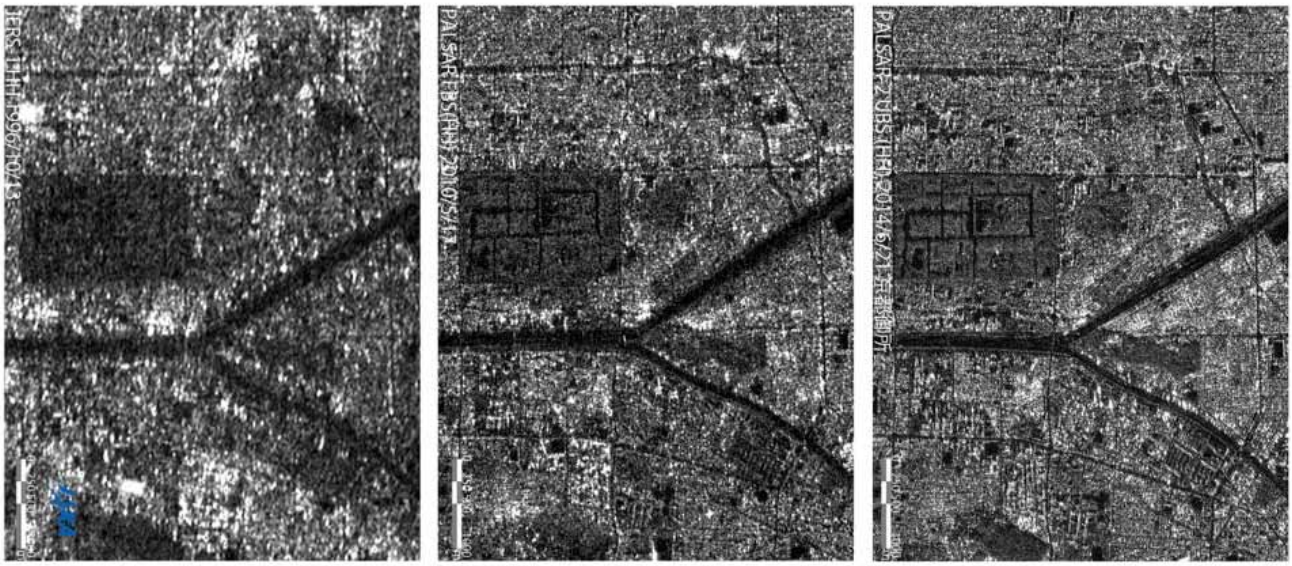
神戸ポートアイランド

PALSAR

PALSAR-2

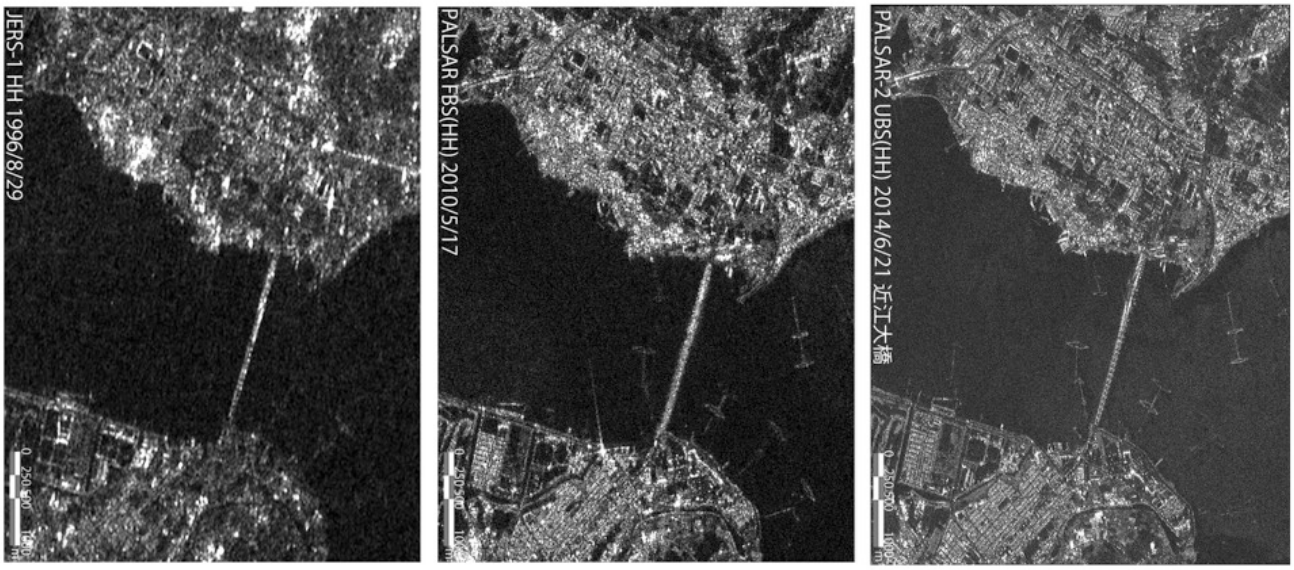
Kyoto imperial place

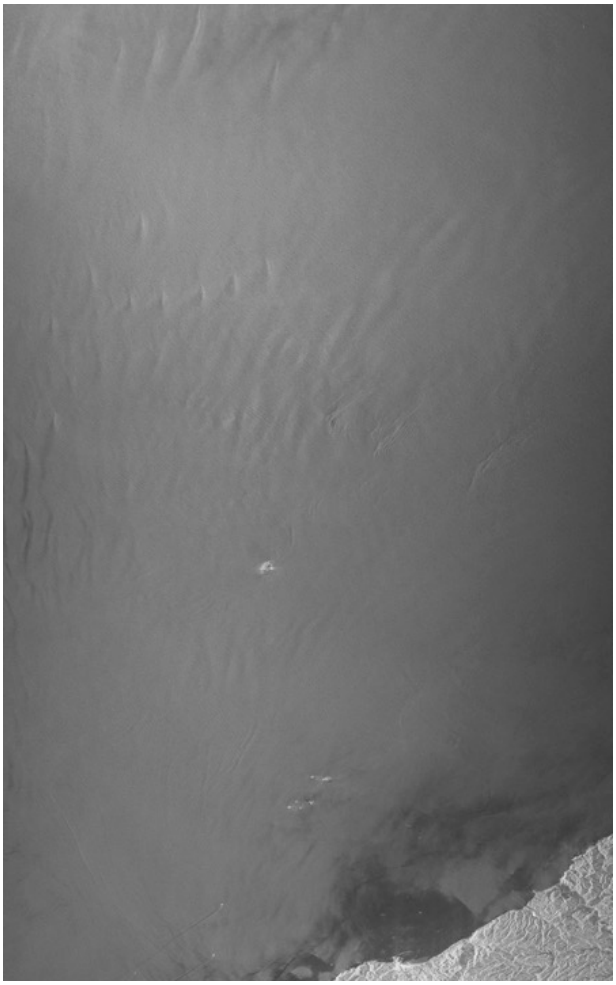
JERS-1(1992) ALOS/PALSAR(2006) ALOS-2/PALSAR-2/(2014)



Biwa Lake Ohmi Bridge

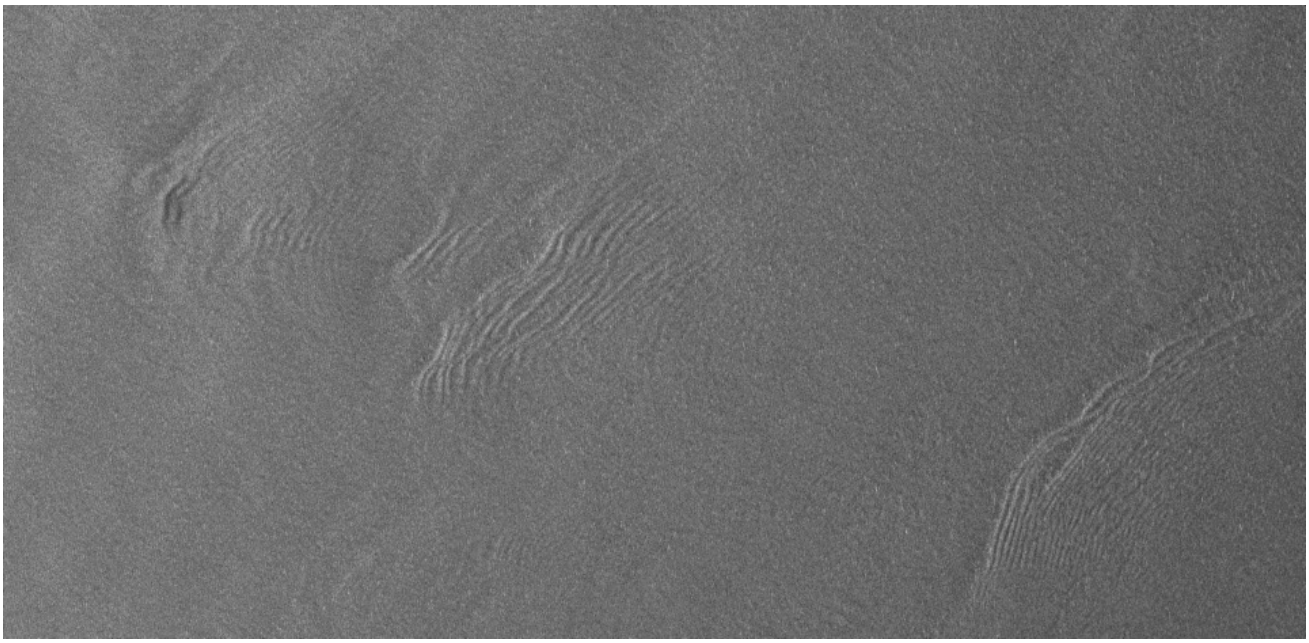
JERS-1(1992) ALOS/PALSAR(2006) ALOS-2/PALSAR-2/(2014)





Ocean Image

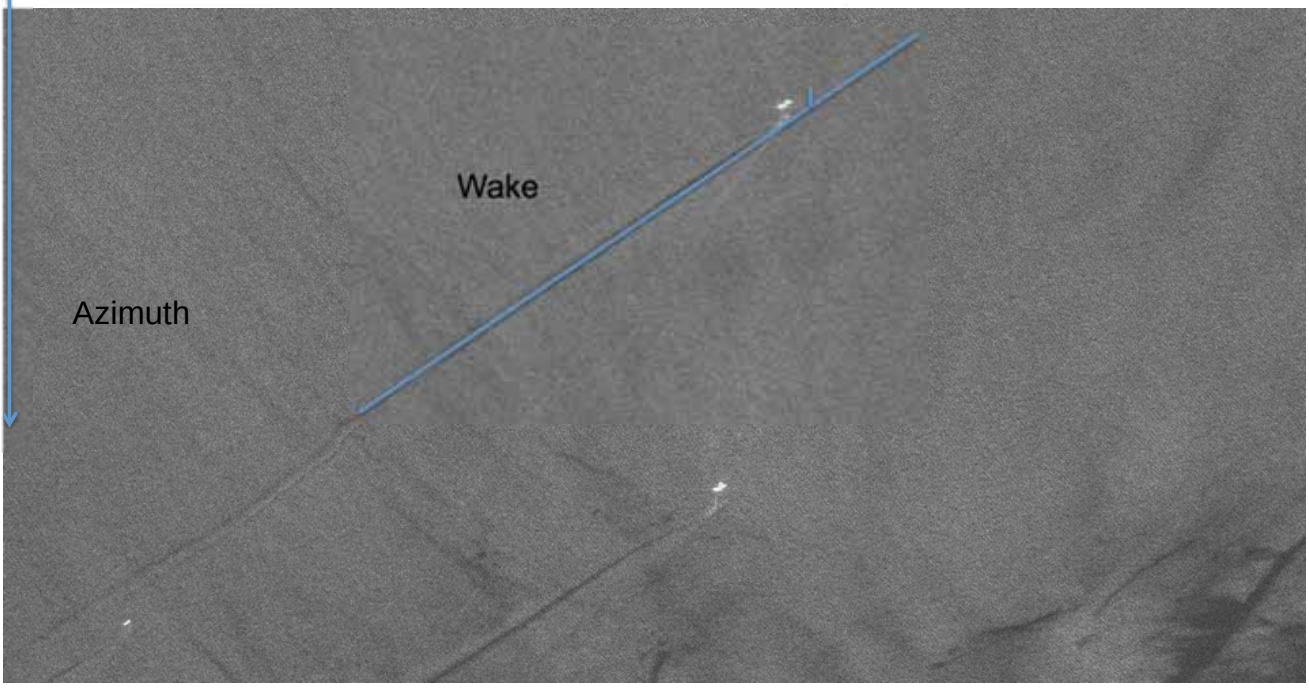
Ocean wave ~~~



Ship Detection and wake

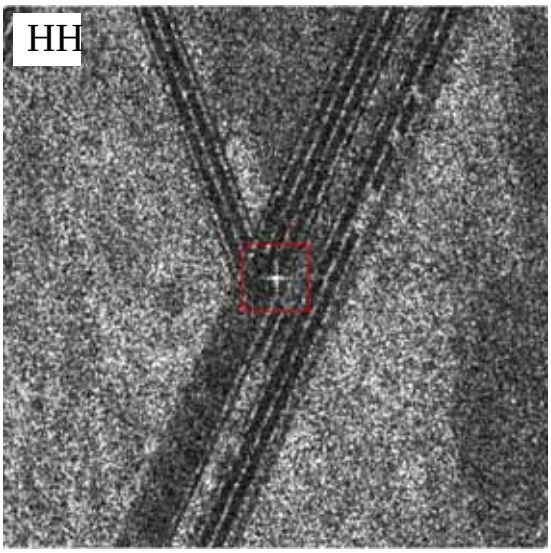
Range direction

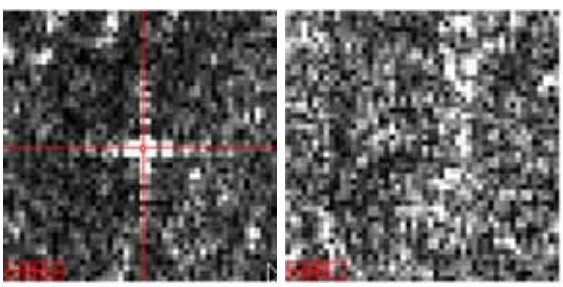
Shift due to negative Doppler



IRF of CR

FBD282/RSP076/2014.10.19/Alaska01(CR3.0m)

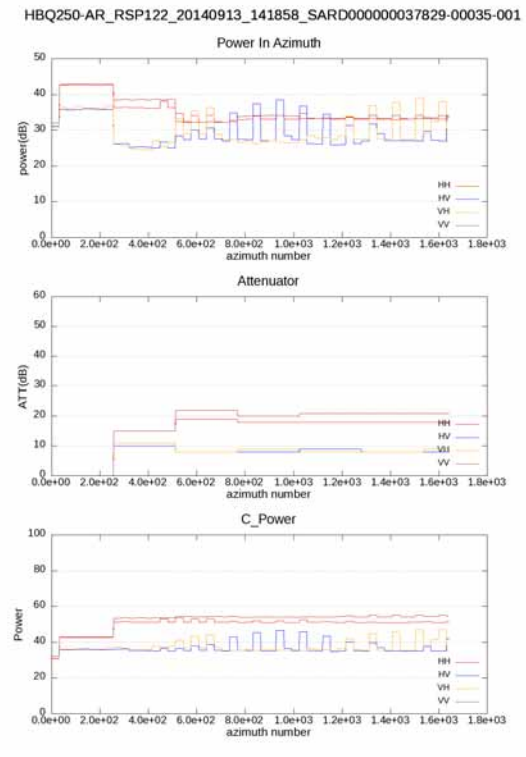




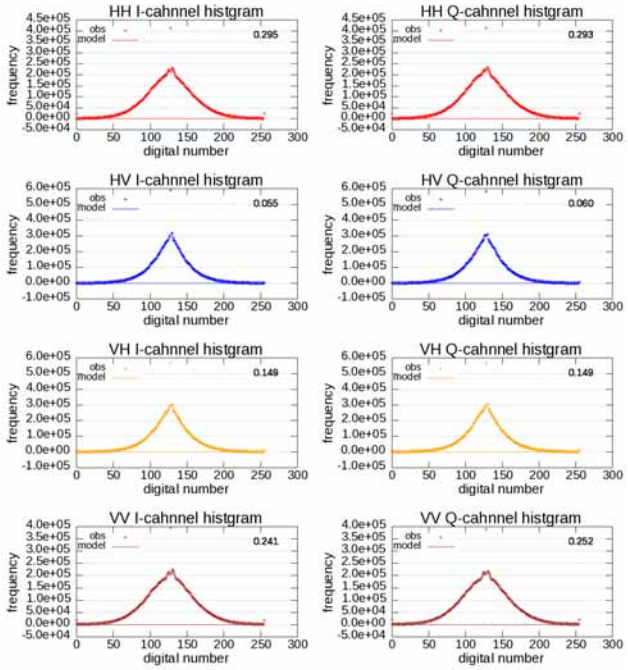
HH HV

4.2.4 Example of raw data characteristic HBQ(High Beam Quad pol) 6m 42MHz

Azimuth profiles



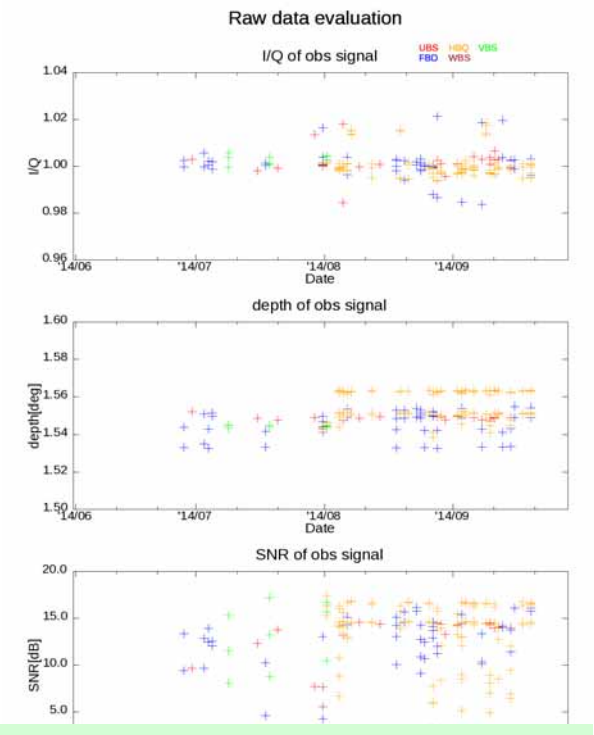
Histograms



Saturation ratio (%)

	HH	HV	VH	VV
I-cha	0.296	0.055	0.149	0.241
Q-cha	0.293	0.060	0.149	0.252

Trend monitoring of the observation data



- SNR(PALSAR2) > PALSAR by 5 dB
- Saturation < mainly 1%

Total characteristics

mode	I/Q	depth [deg]	SNR [dB]	Sat [%]	Scene
3m	1.0022 (0.0065)	1.5491 (0.0012)	13.2852 (1.9119)	0.205	21
6m	1.0002 (0.0052)	1.5557 (0.0071)	13.7788 (3.2357)	0.295	29
10m	1.0009 (0.0068)	1.5445 (0.0075)	12.6178 (2.7583)	0.526	26
ScanSAR [350km]	1.0003 (0.0006)	1.5458 (0.0030)	9.3965 (6.7832)	0.012	2
ScanSAR [490km]	1.0029 (0.0021)	1.5446 (0.0005)	13.0030 (3.4342)	5.551	3

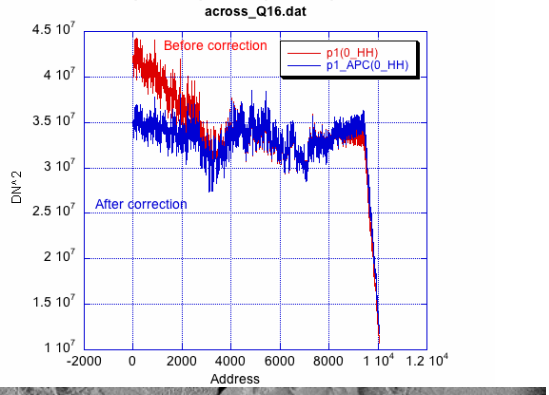
（参考）PALSAR

mode	I/Q	dPH	SNR	Sat
FBS	1.007	1.598	8.423	LS 5%
FBD	1.010	1.579	3.358	LS 5%
PLR	1.001	1.577	8.712	LS 5%
WB1	1.015	1.581	7.926	LS 5%
WB2	1.008	1.597	8.733	LS 5%

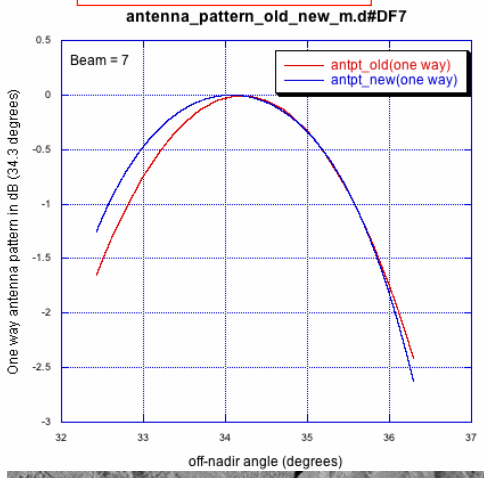
Antenna Pattern Estimation

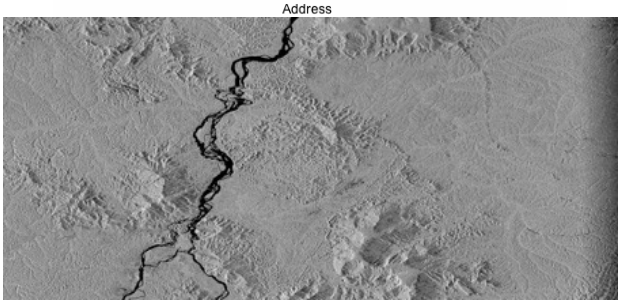
•アマゾンから一様領域の抽出（フィルター処理
•4次式の推定
•アンテナパターンdBの更新

$$G(\theta) = a + b(\theta - \theta_0)^2 + c(\theta - \theta_0)^4$$

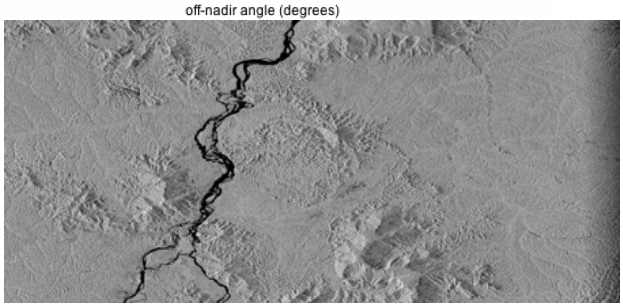


$g^0(s^0/\cos(q))$= 定数





Before



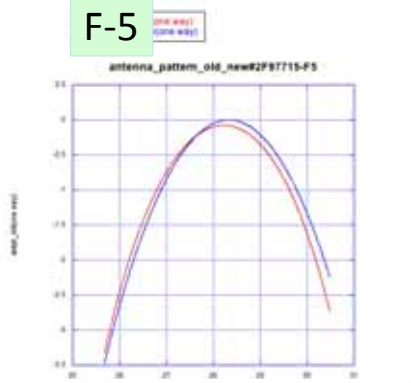
After

4.2.6 校正（ラジオメトリック校正（エレベーション・アンテナパターン補正））

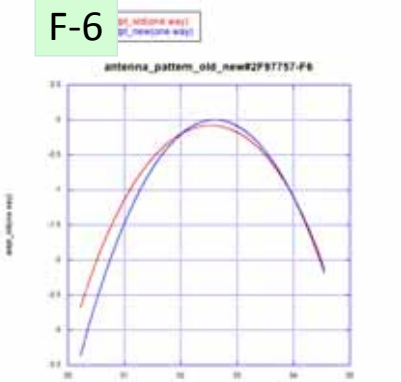
多少アンテナパターンは変化しており、その変化を処理に反映

実データ（アマゾンより抽出）
F-5

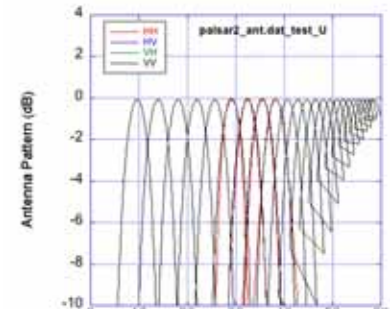
F-5



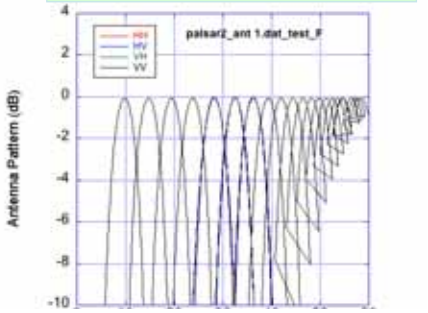
F-6



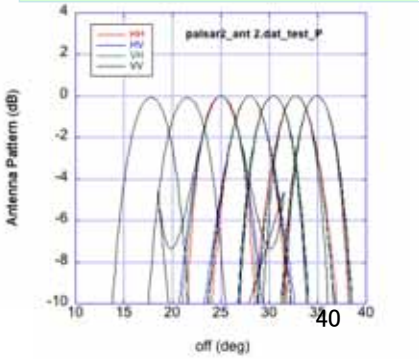
UBS antenna pattern



FB antenna pattern



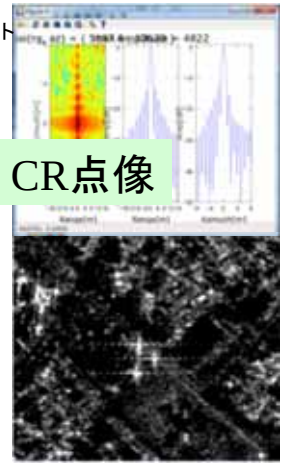
HBQ antenna pattern



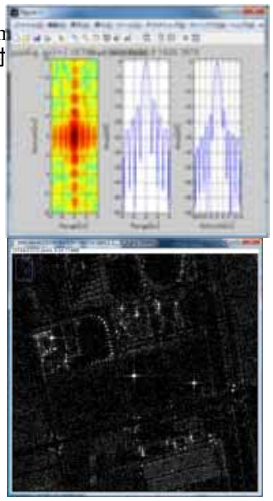
赤：地上計測データ、青：軌道上データ（アマゾンデータを解析）

4.2.8 CR点像

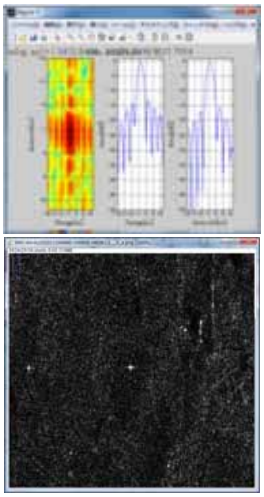
スポットライト
6/19 神戸



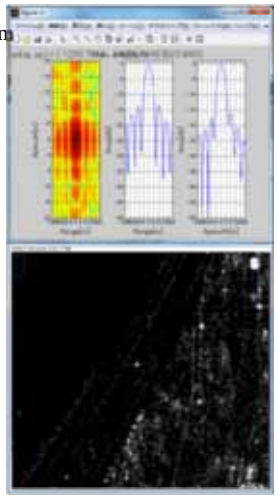
高分解能3m
7/16 読谷村



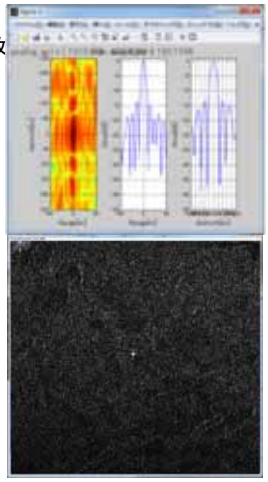
高分解能6m
8/8 リオブランコ



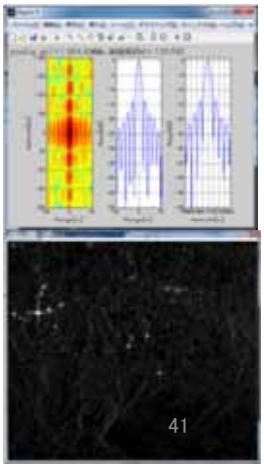
高分解能10m
8/19 渡良瀬



広域350km
10/14 苫小牧



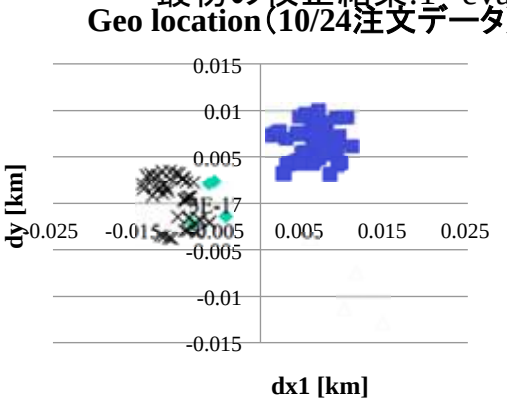
広域490km
7/19 苫小牧



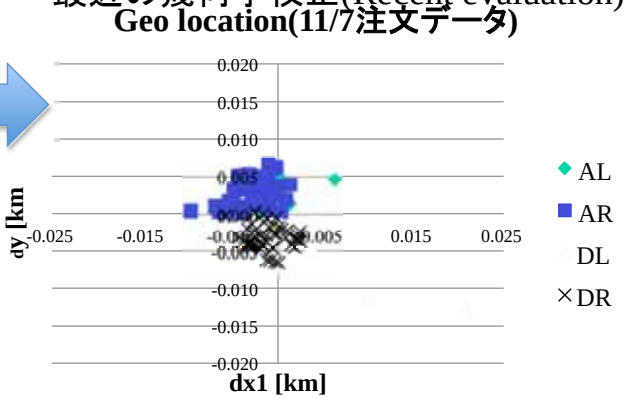
4.2.8 幾何精度評価結果(Strip(U-H-F)):Geo location evaluation)

全世界に展開したCRを用いてレンジゲート時間遅れの調整

最初の校正結果:1st evaluation)



最近の幾何学校正(Recent evaluation)

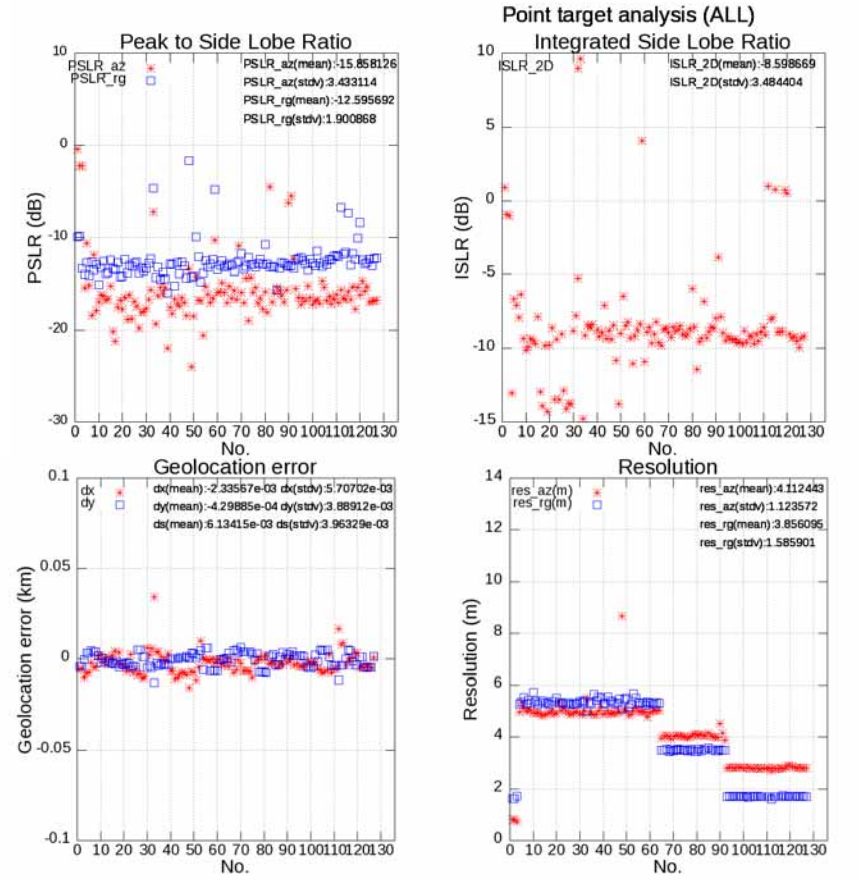


Improvement of the geometric accuracy

5.34m (RMSE)

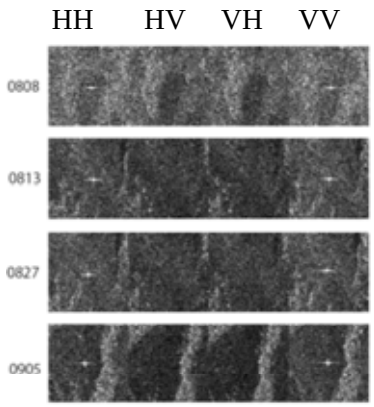
mode	dx1平均値[m]	dx1標準偏差	dy平均値[m]	dy標準偏差	評価点数	RMSE
A/L	0.839451	2.563070	2.574452	2.080054	7	4.23
A/R	-2.874292	2.035313	2.808302	1.734837	58	4.83
D/L	3.835954	5.598194	-5.899280	3.284252	14	9.57
D/R	-1.151538	1.987740	-3.185586	1.653553	48	4.26

4.2.8 ポイントターゲット評価結果:Point target evaluation result



Peak to side lobe ratio
Integrated Sidelobe ratio
分解能
幾何学精度
全てに渡って良好な性能を示す。

Polarimetric Calibration(1/2)



Response from the CR in Amazon shows very small cross talks in HV and VH.

Polarimetric calibration equations

$$\begin{pmatrix} Z_{hh} & Z_{hv} \\ Z_{vh} & Z_{vv} \end{pmatrix} = Ae^{\frac{-4\pi r}{\lambda}} \begin{pmatrix} 1 & \delta_3 \\ \delta_4 & f_2 \end{pmatrix} \begin{pmatrix} \cos\Omega & \sin\Omega \\ -\sin\Omega & \cos\Omega \end{pmatrix} \begin{pmatrix} S_{hh} & S_{hv} \\ S_{vh} & S_{vv} \end{pmatrix} \begin{pmatrix} \cos\Omega & \sin\Omega \\ -\sin\Omega & \cos\Omega \end{pmatrix} \begin{pmatrix} 1 & \delta_1 \\ \delta_2 & f_1 \end{pmatrix} + \begin{pmatrix} N_{hh} & N_{hv} \\ N_{vh} & N_{vv} \end{pmatrix}$$

RD TD

→ Determination of the unknowns(Amazon+CR)

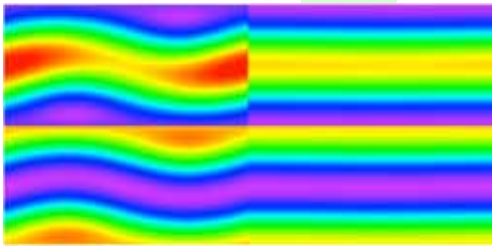
1）クロストークは−40dB以下と良好な特性を示す:Cross talk is less than -40 dB)

2）チャンネルインバランスの適切性：以下のポラリメトリックシグナチャーで確認

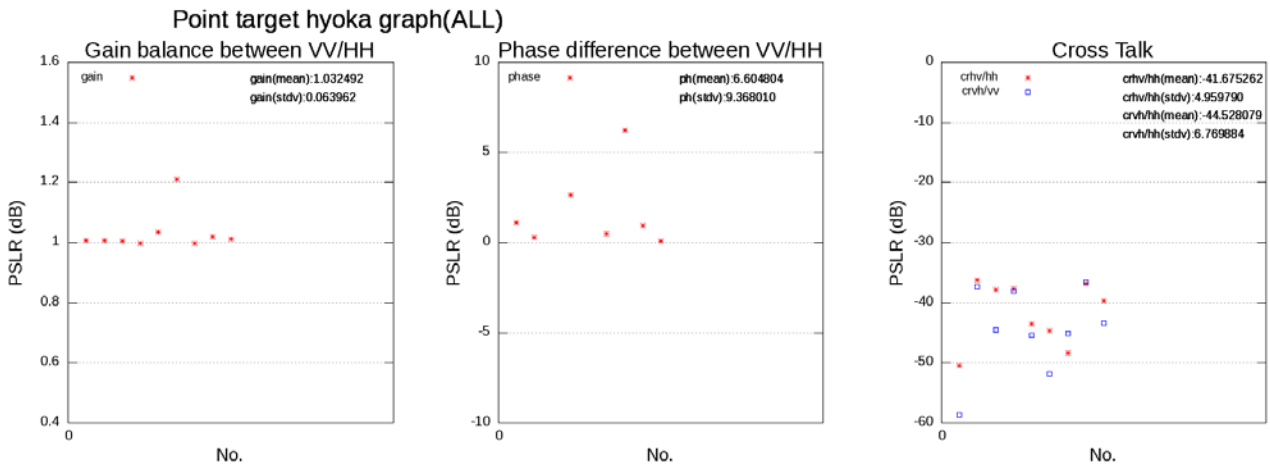
解析例（23°）

Trans Distorsion
=
(1.0000e+00 0.0000e+00) (2.9780e-03 2.6764e-03)
(2.7118e-03 1.6514e-03) (9.1212e-01 -4.8408e-01)
Receiver Distorsion
=
(1.0000e+00 0.0000e+00) (-3.2790e-03 2.6533e-03)
(4.7041e-03 7.2861e-03) (1.0681e+00 -1.9712e-02)

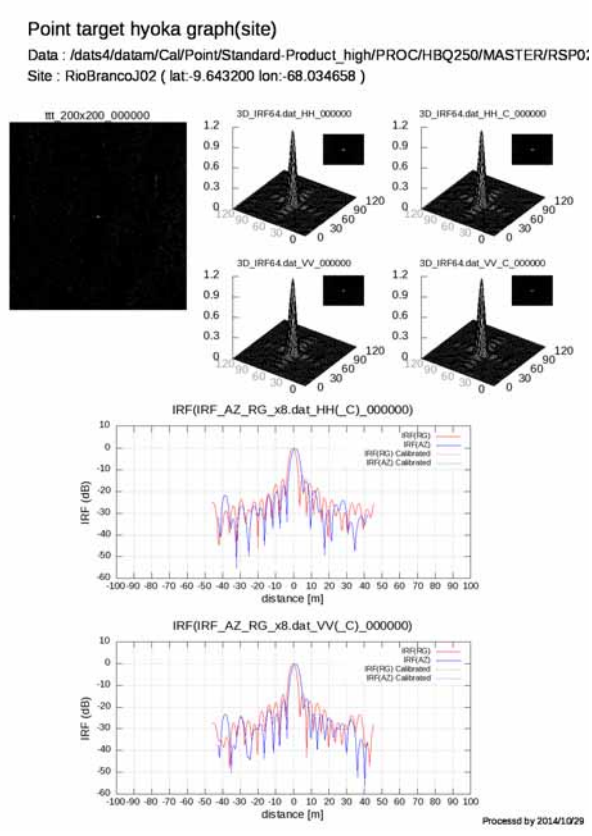
Before → After

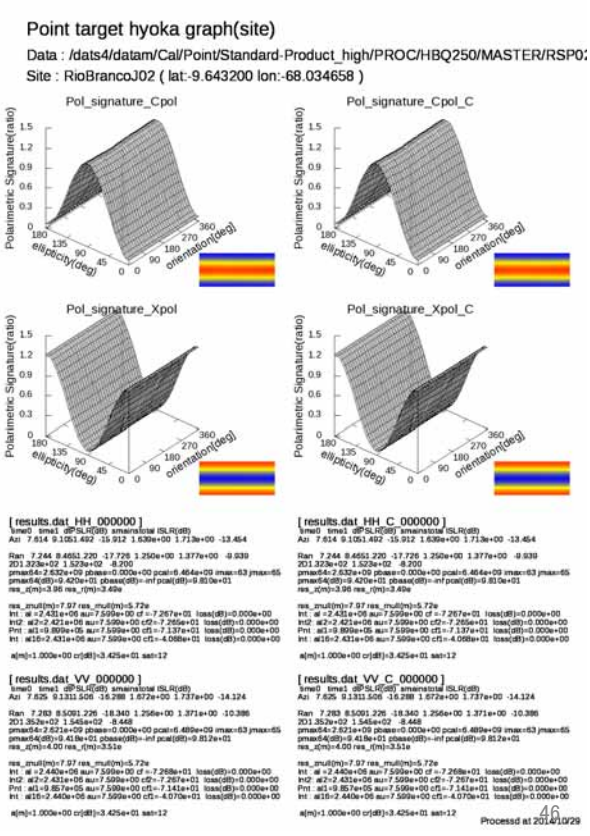


4.2.7　ポラリメトリック校正(2/2)



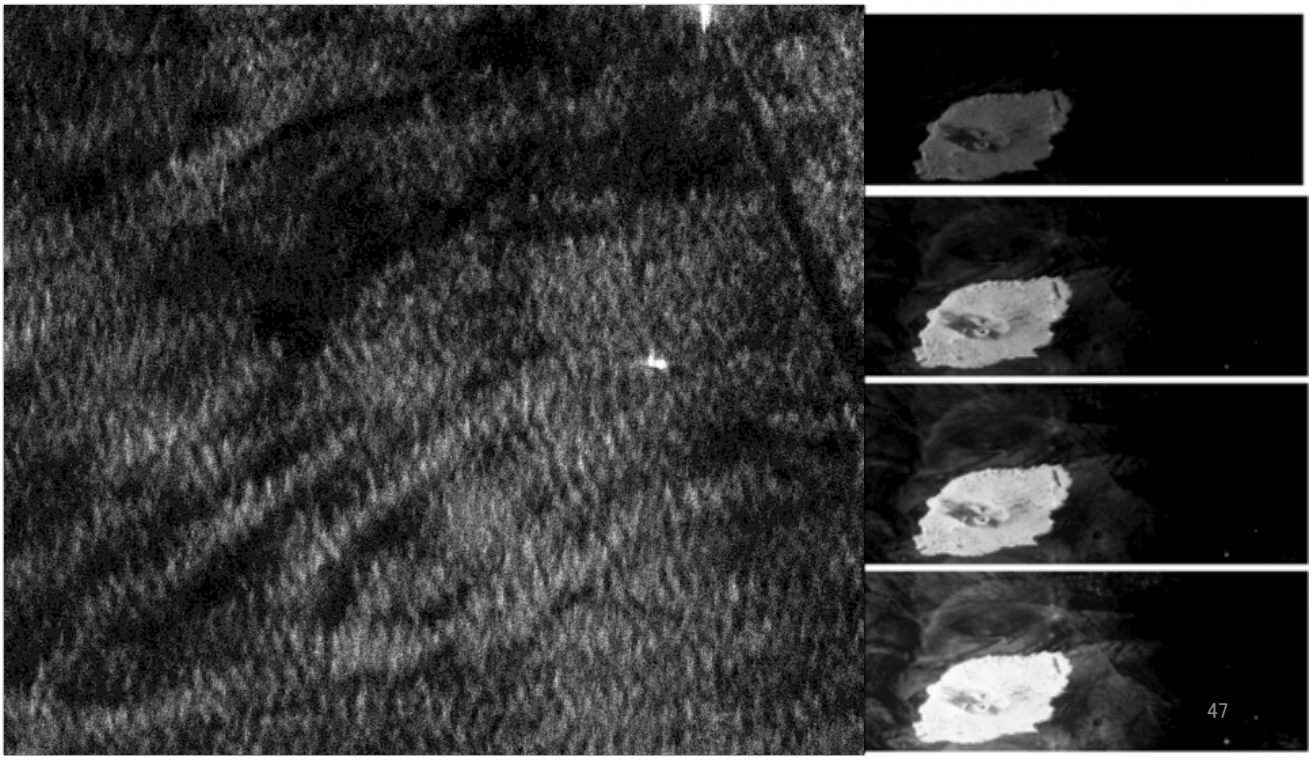
Point Target Aanalysis（IRF, Polarimetric Signature)





Range Ambiguity Suppression

- Range Ambiguity often occurs at and of the image swath.
- Up/down and M-series Pi is added in the transmission signal code in order to suppress the RA in 10 dB.



Noise Equivalent Sigma-Zero(NESZ)

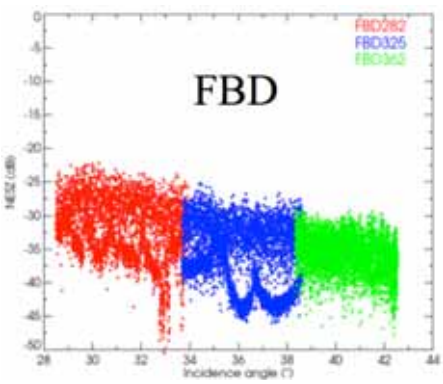
Minimum Values

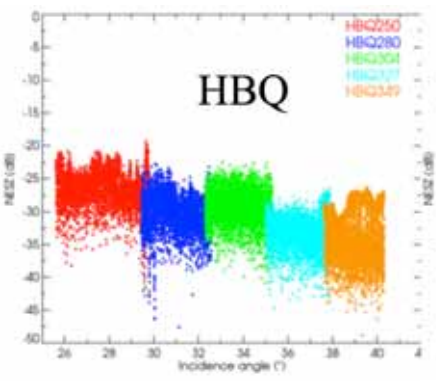
ファイル名	最低値	平均値	中央値
FBD282_ALOS2017377150-140918	-50.53501	-35.11314	-34.83520
FBD325_ALOS2020930210-141012	-45.97483	-40.21743	-41.06180
FBD362_ALOS2016050160-140909	-47.88250	-36.53103	-36.55561
HBQ250_ALOS2016630850-140913	-42.82800	-27.89674	-27.58296
HBQ280_ALOS2024177180-141103	-47.58296	-31.23381	-31.00234
HBQ304_ALOS2022257190-141021	-40.85580	-29.47732	-29.24942
HBQ327_ALOS2014717190-140831	-44.72372	-33.82870	-33.57417
HBQ349_ALOS2013230840-140821	-48.84860	-36.17019	-35.95635
UBS291_ALOS2023513470-141030	-49.37518	-36.36374	-36.59707
UBS354_ALOS2024470670-141105	-45.97483	-33.81170	-33.60356
UBS382_ALOS2023290600-141028	-49.93575	-35.40385	-35.57864

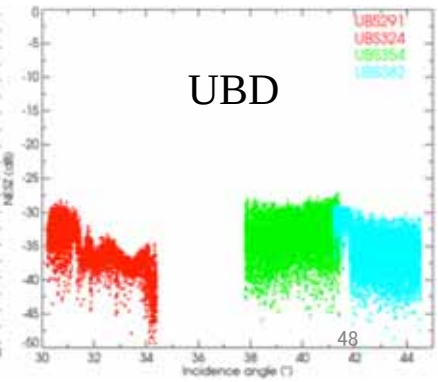
-41.1

-36.0

-36.6







4.2.9 Conversion to the NRCS

$$\sigma^0{}_{sigma-sar,Q16} = 10 \cdot \log_{10}\left\langle DN^2 \right\rangle + CF_1$$

$$\sigma^0{}_{sigma-sar,slc} = 10 \cdot \log_{10}\left\langle I^2 + Q^2 \right\rangle + CF_1 - A$$

CF	mean(dB)	std (dB)
CF_1	-83.0	0.406
A	32.0	-

A

Coefficient	Values
Range time corrections	-22.7nsec.(-68.10m shift)
Azimuth time offset	0
PolCal coefficient(i.e., 23 degrees)	**Trans Distorsion = (1.0000e+00 0.0000e+00) (2.9780e-03 2.6764e-03) (2.7118e-03 1.6514e-03) (9.1212e-01 -4.8408e-01) Receive Distorsion = (1.0000e+00 0.0000e+00) (-3.2790e-03 2.6533e-03) (4.7041e-03 7.2861e-03) (1.0681e +00 -1.9712e-02)**

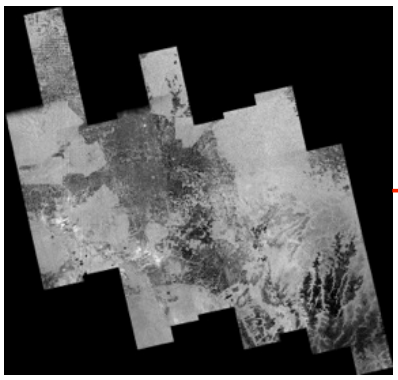
Initial Calibration（Summary）(2014/11/20)

Items	Results		Data	Requirement
Geometry (RMSE)	High resolution/ Spotlight mode	5.34m(L 1.1) / 6.73m(L 2.1)	127/129	20m
	ScanSAR mode	60.77m(L1.1)/29.93m(L2.1)	7/8	100m
Radiometry	Corner reflector Amazon（forest） NESZ（F/H/U） HH HV	1.31（CF：-81.60） 0.406（CF:-82.34） -41.1(F)/-36.0(H)/-36.6(U) -49.2(F)/-46.0(H)	120 30 scenes	1.0 dB 1.0 dB:-6.84dB@Amazon -26.0(F)/-28.0(H)/-24.0(U)
Polarimetry	VV/HH VV-HH phase(deg) Cross talk (dB)	1.0143(σ：0.06) 0.350(σ：0.286) -43.7(σ：6.65) hv/hh -44.0(σ：7.10) vh/vv -48.2(σ：6.05) corr	6	1.047 5 deg -30dB -30dB -30dB
Resolution(m) **Azimuth/range**	Spotlight High resolution[3m] High resolution[6m] High resolution[10m]	0.79(σ：0.028)/1.66(σ：0.04) 2.81(σ：0.034)/1.70(σ：0.022) 4.06(σ：0.108)/3.53(σ：0.317) 5.05(σ：0.110)/5.36(σ：0.126)	3 35 28 61	1.00x1.1/1.78 2.75x1.1/1.78 3.75x1.1/3.57 5.00x1.1/5.36
Sidelobes	PSLR（azimuth） PSLR（range） ISLR	-16.20(σ：2.53) -12.59(σ：1.84) -8.80(σ：3.23)	124	-13.26dB+2dB -13.26dB+2dB -10.16dB+2dB
Ambiguity	Azimuth Range	23~14(mean:20) Invisible	7 scenes	20~25dB以上 25dB以上

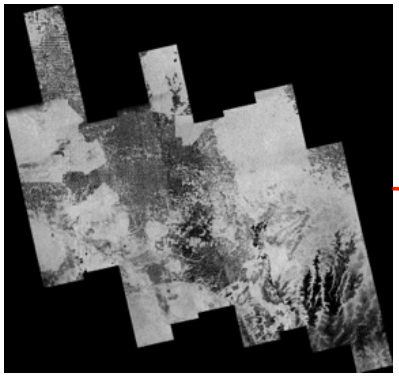
Note:PSLR:Peak to Sidelobe Ratio, ISLR: Integrated Sidelobe Ratio, U is high resolution[3m], H for [6m], F for [10m].
Standard dev. of CF is 1.31 will be tuned under 1.0 synchronized with Amazon calibration data.

Application Examples

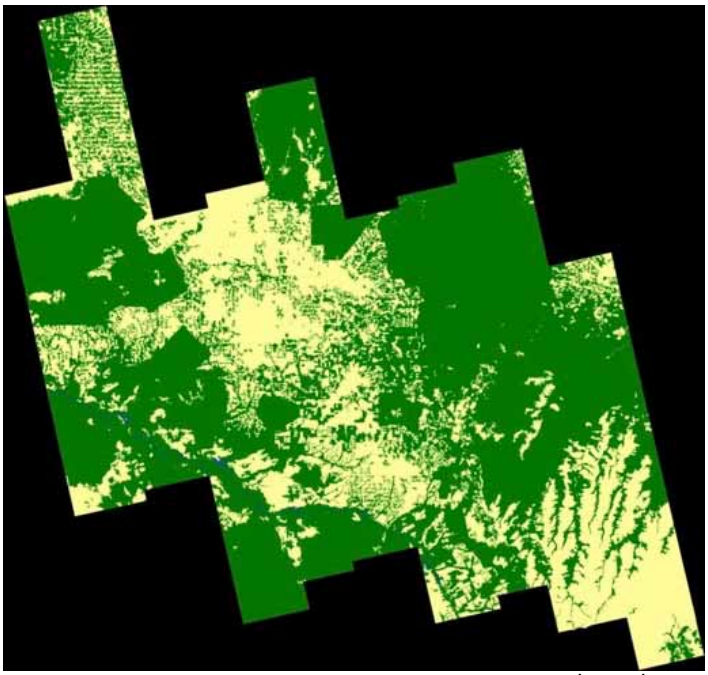
25m PALSAR-2 mosaic and the forest/non-forest data（FNF map generation）



HH



HV

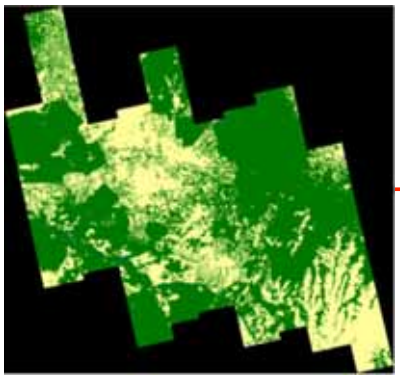


25m PALSAR-2　Forest/Non-forest map（FNF）

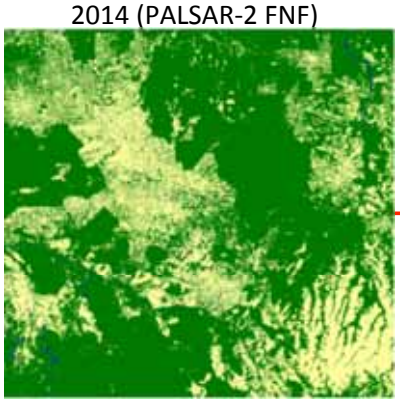
25m PALSAR-2モザイクから森林・非森林の分類により，森林伐採の状況把握が可能

（9 path images including the south America's forest/non-forest regions

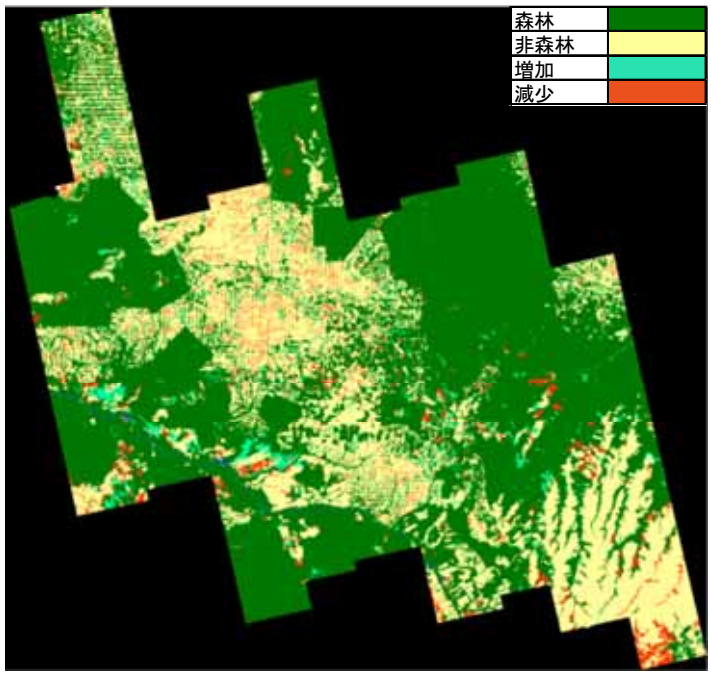
25m PALSAR-2 モザイクによる森林・非森林（FNF: change detection of the forest area）



2014 (PALSAR-2 FNF)



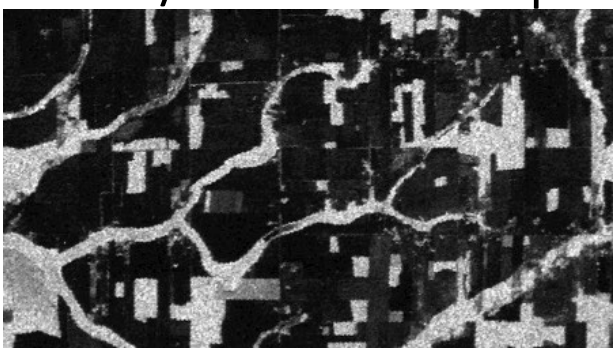
2010 (PALSAR FNF)



Change detection of the FNF2010 and FNF2014

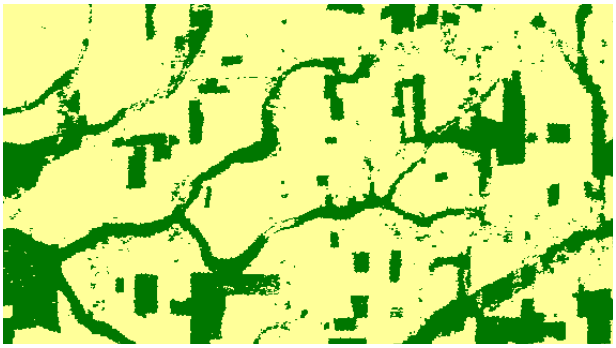
2010年から2014年の森林面積変化が把握可能
PALSARに比べて分解能の向上，NESZが小さい為に良好な分類が可能になる。

PALSAR/PALSAR-2 Comparison

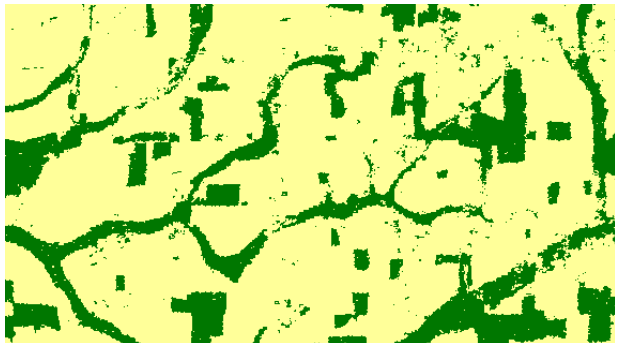


PALSAR FBD HV

PALSAR-2 F2-5 HV



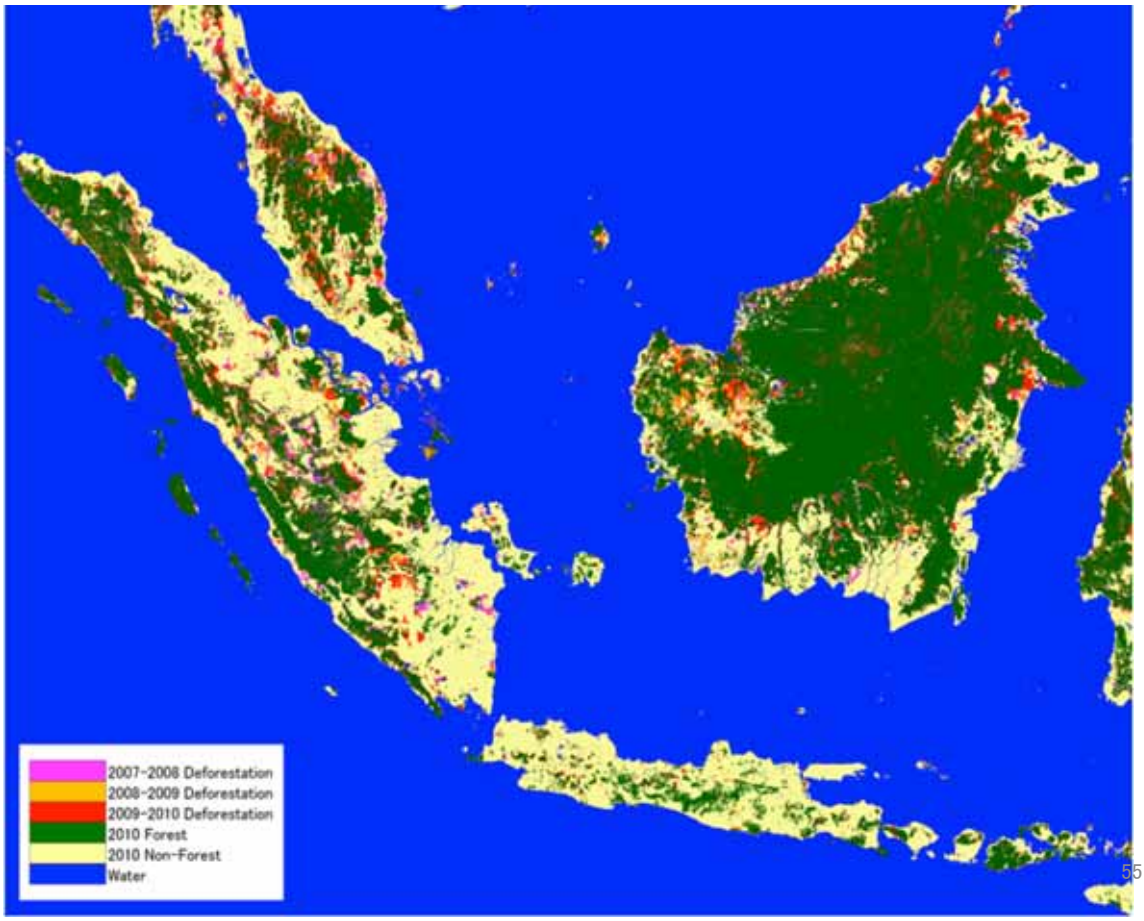
PALSAR FNF (2010)



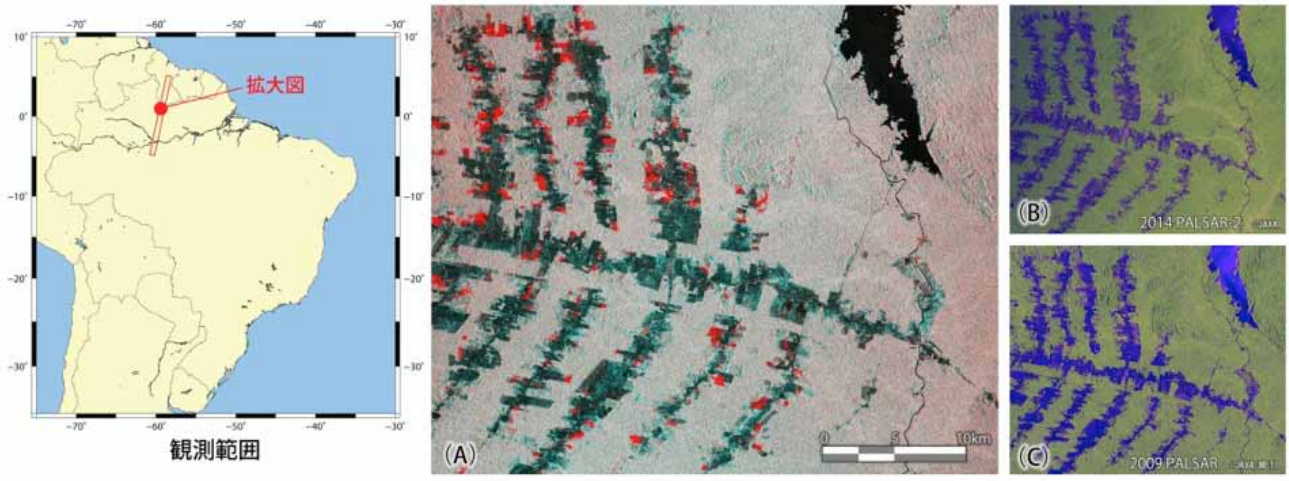
PALSAR-2 (2014)

PALSAR HVと比較し，PALSAR-2 HVは植生の異なる領域のエッジがはっきりしており，森林・非森林の視認精度が向上した。

Annual Deforestation diversity map using the PALSAR (2007-2010)

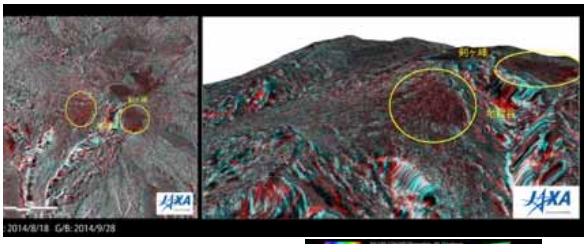


- Forest monitoring using Dual Strip SAR :
  PALSAR data were provided to IBAMA of Brazil for monitoring the illegal logging. PALSAR-2 will be provided to more agencies.

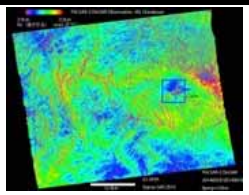


- (A)はブラジル国・ロライマ州東部の森林減少が平成21年と比べて現在どのように変化したかをとらえたものです。この画像は今回「だいち2号」のPALSAR-2が観測した2014年6月21日の画像(B)と平成21年の「だいち」搭載PALSARによる画像(C)を用いて色合成しています(水色が非森林、灰色が森林、赤色が5年間に減少した森林域を示します)。
- この画像の範囲で約25.0 km^2の森林減少が見られます。森林の観測に適したLバンドの波長の電波を用いたPALSAR-2により、今後、世界規模の森林観測が可能になります。その結果、森林管理や、気候変動に大きな関わりがあるとされる森林のバイオマス量の推定に貢献できると期待されます。

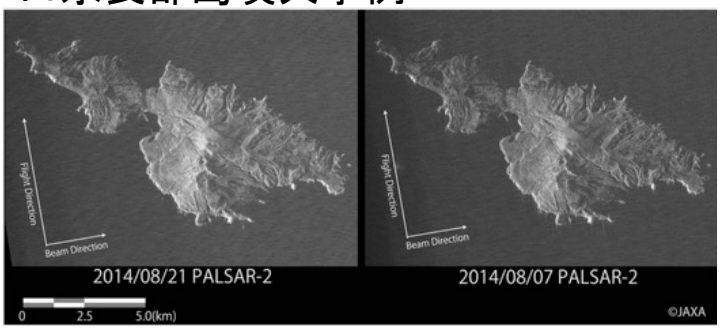
Deformation Monitoring : Volcano and Earthquake

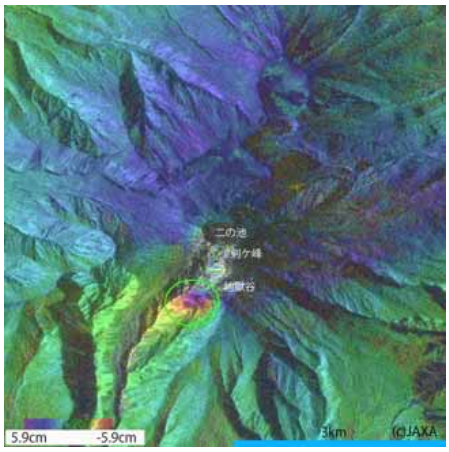


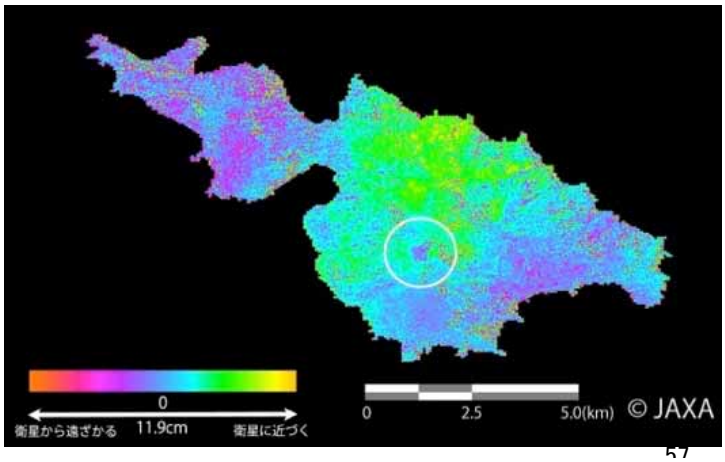
Mt. Ontake Eruption



口永良部島噴火事例







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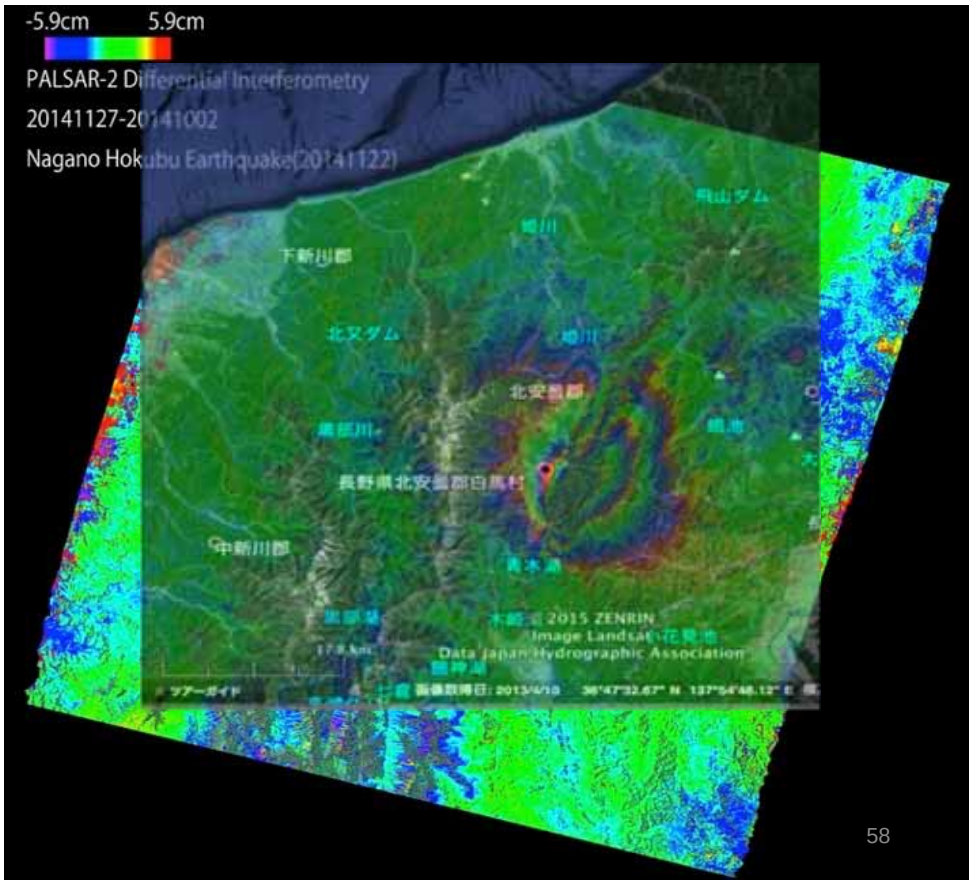
Northern Nagano Earthquake (DinSAR), Nov. 22

長野県北部地震の観測（干渉SAR）

２０１４年長野県北部地震は同年１１月２２日２２時８分頃に、日本の長野県北部長野県北安曇野郡白馬村を震源として発生したマグニチュード６.７の地震。長野県は神城断層地震と統一している。小谷村、小川村、長野市で最大震度６弱を観測した。震源断層は、白馬村と小谷村を縦断する神城断層である。



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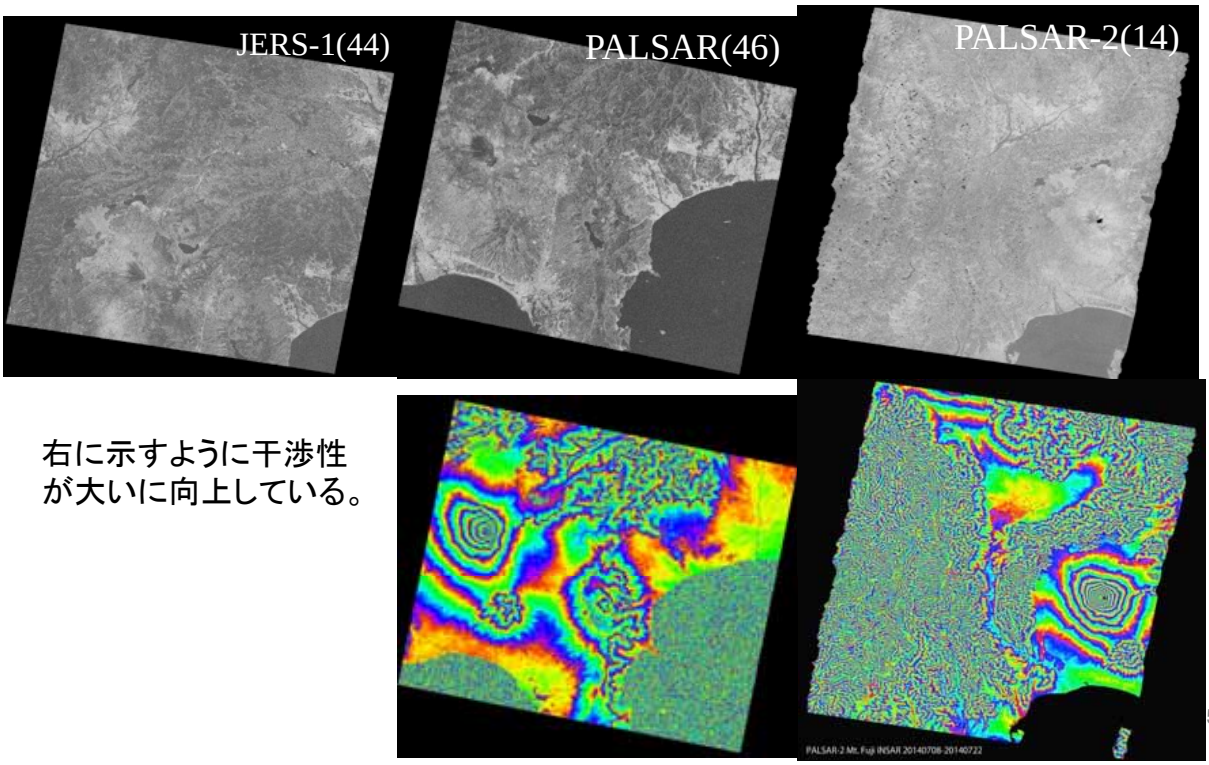
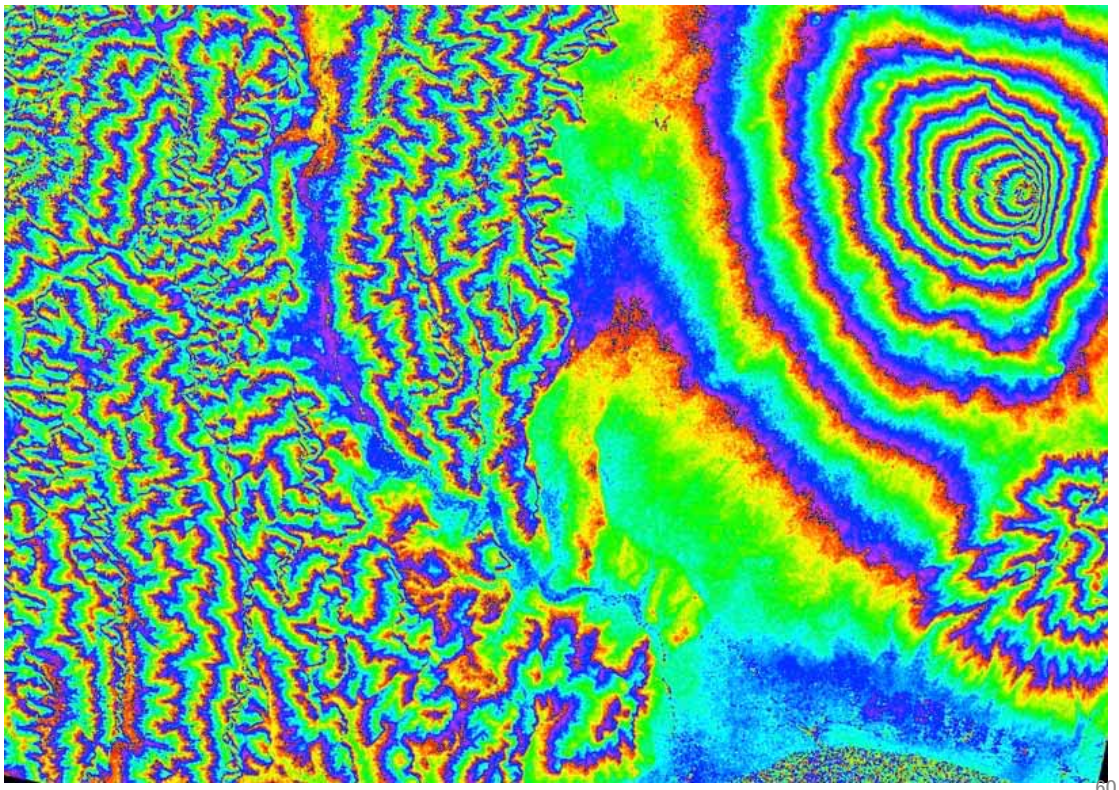
Coherence improvement of the PALSAR-2

JERS-1/ALOS/ALOS-2の変遷において1）送信電力，2）SNR、3）軌道制御，4）帯域幅が向上しており，合わせて干渉性が向上している。以下に、事例を紹介する。
From JERS-1/ALOS/ALOS-2, 1) Transmission power, SNR increases, and bandwidth increase, and autonomous orbit maintenance , improves the interferometric coherence.



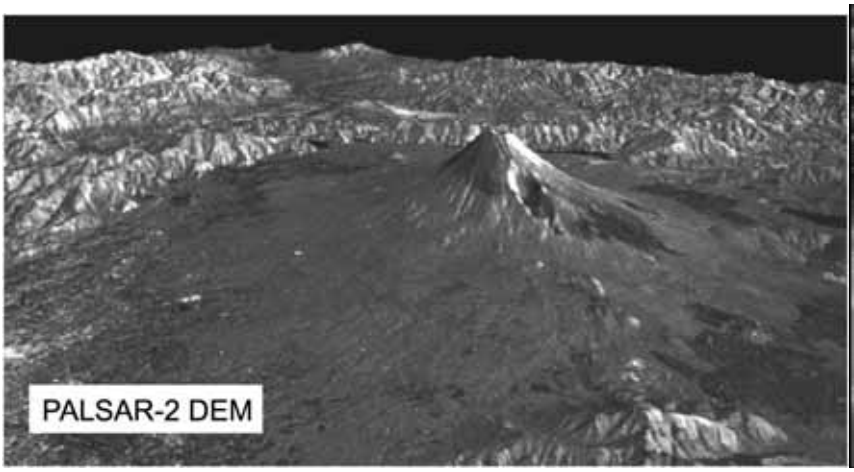
右に示すように干渉性が大いに向上している。

Interferometric SAR

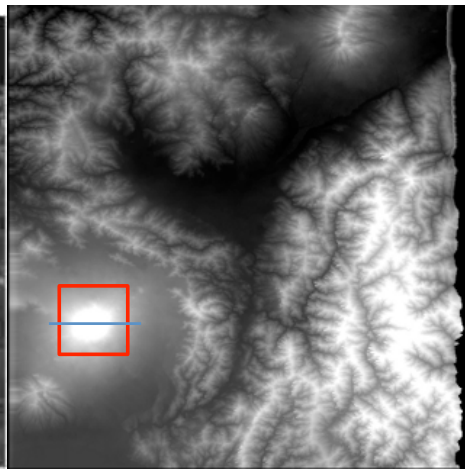


詳細な干渉情報が得られる。

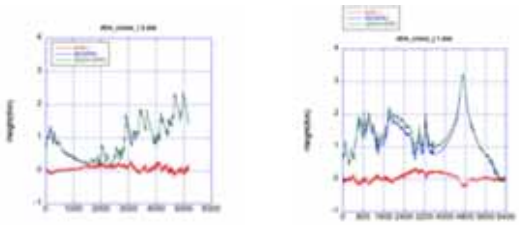
Digital Elevation Model (DEM)



3D image expression of the ortho-rectified PALSAR-2 image suing the generated DEM (nea Mt. Fuji)

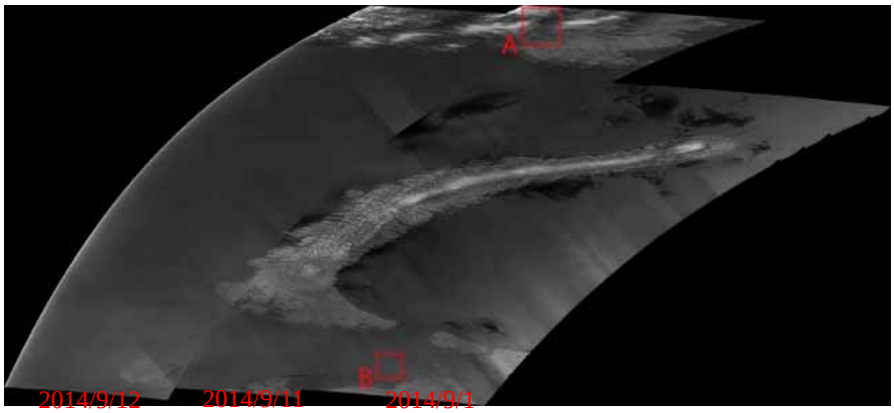


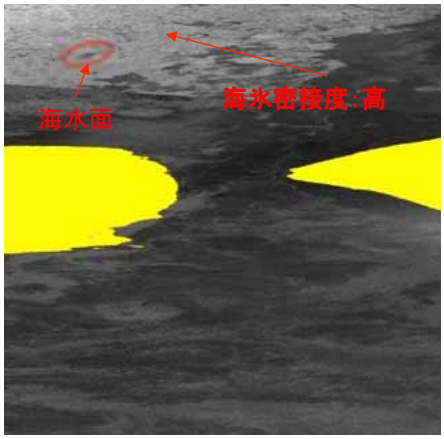
DEM generated by the Unwrapped DinSAR+ DSM



ScanSAR　Sea Ice mosaic using the ScanSAR

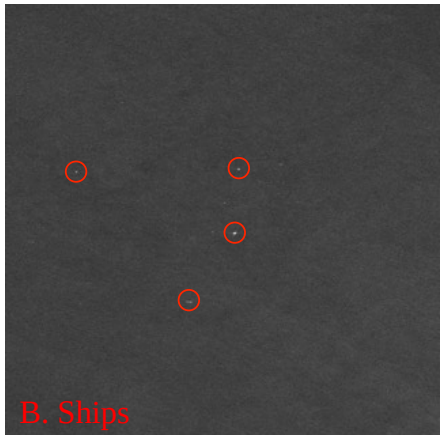
Descending



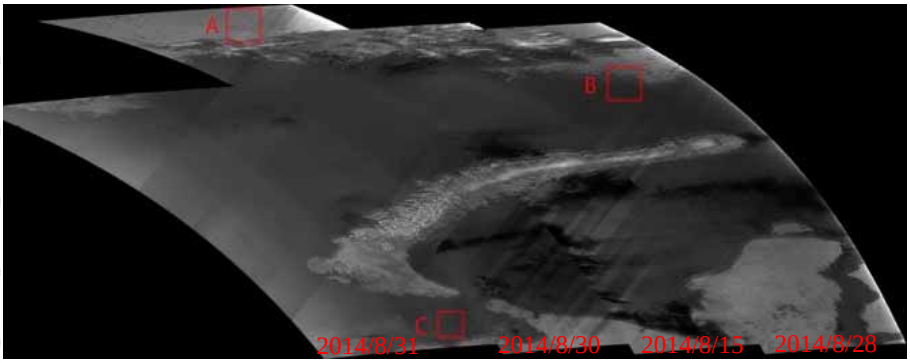


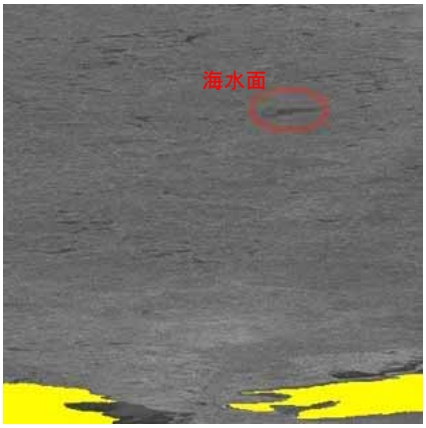
A. Sea Ice

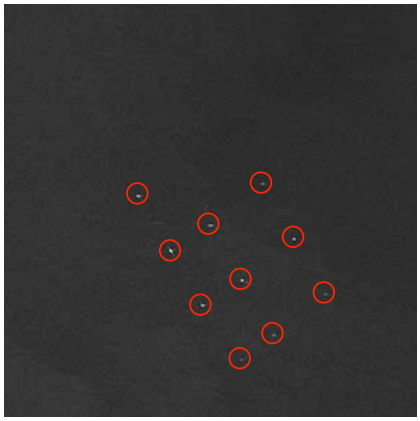
※黄色：陸域



ScanSAR　Sea Ice detection from ScanSAR mosaic　Ascending







A.　High seaice density
※Yellow：land mask

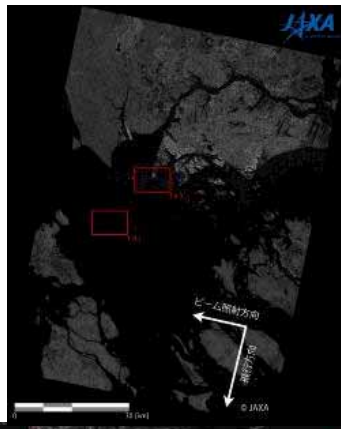
B.　Low seaice density

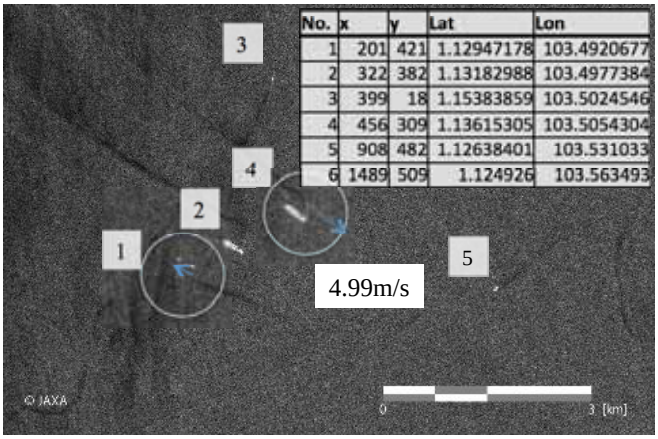
C.　ships

Ship detection

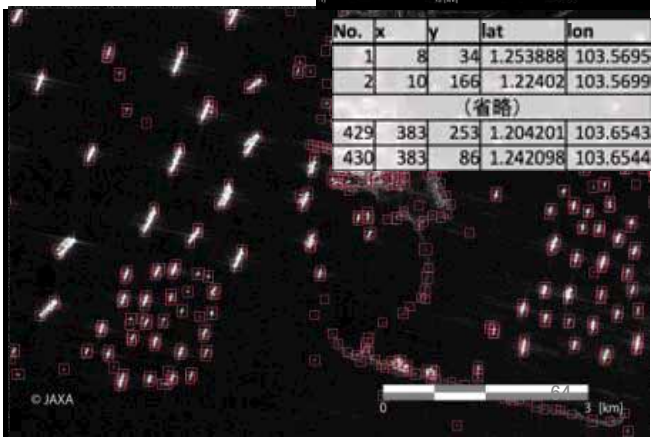
Sample image of the ship detection using the FB over the Malaysia off ocean. Lower NESZ allows the detection of the ship easier than PALSAR.

（観測日：2014/7/14, VV pol.）





No.	x	y	Lat	Lon
1	201	421	1.12947178	103.4920677
2	322	382	1.13182988	103.4977384
3	399	18	1.15383859	103.5024546
4	456	309	1.13615305	103.5054304
5	908	482	1.12638401	103.531033
6	1489	509	1.124926	103.563493

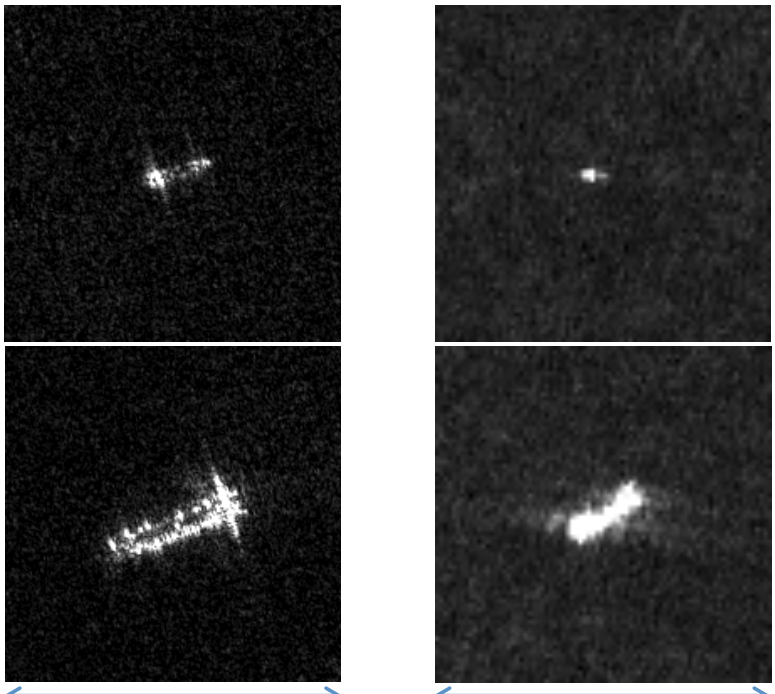


No.	x	y	lat	lon
1	8	34	1.253888	103.5695
2	10	166	1.22402	103.5699
（省略）				
429	383	253	1.204201	103.6543
430	383	86	1.242098	103.6544

Comparison of the PALSAR-2 and PALSAR: Ships in Tokyo bay

Ships with 80m

170m



500m　　500m

PALSAR-2 has 84 MHz band width detects the structure of the larger ship

PALSAR-2
観測日：2014/8/29
高分解能（3m）モード

PALSAR
観測日：2010/7/22
高分解能（10m）モード

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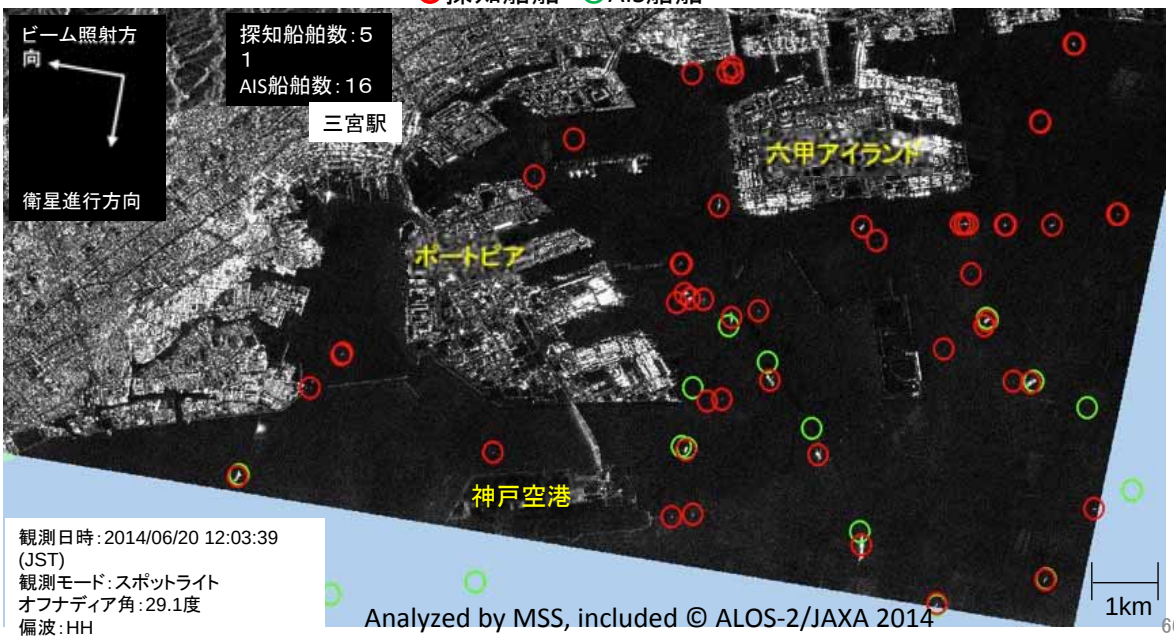
（3） Ocean and ship detection

〇AIS信号を発していない船舶等にも対応可能な合成開口レーダ（SAR）による船舶の有無確認。
　ALOS-2（陸域観測技術衛星2号）では、SARとAISを同時搭載。
〇探知船舶数が51に対して、AIS船舶数は16（画像上のみ）であり、AISを発信している船舶がわずか
　31%にしか満たないことがわかる。
海洋監視に使用されている。

〇探知船舶　〇AIS船舶



Analyzed by MSS, included © ALOS-2/JAXA 2014

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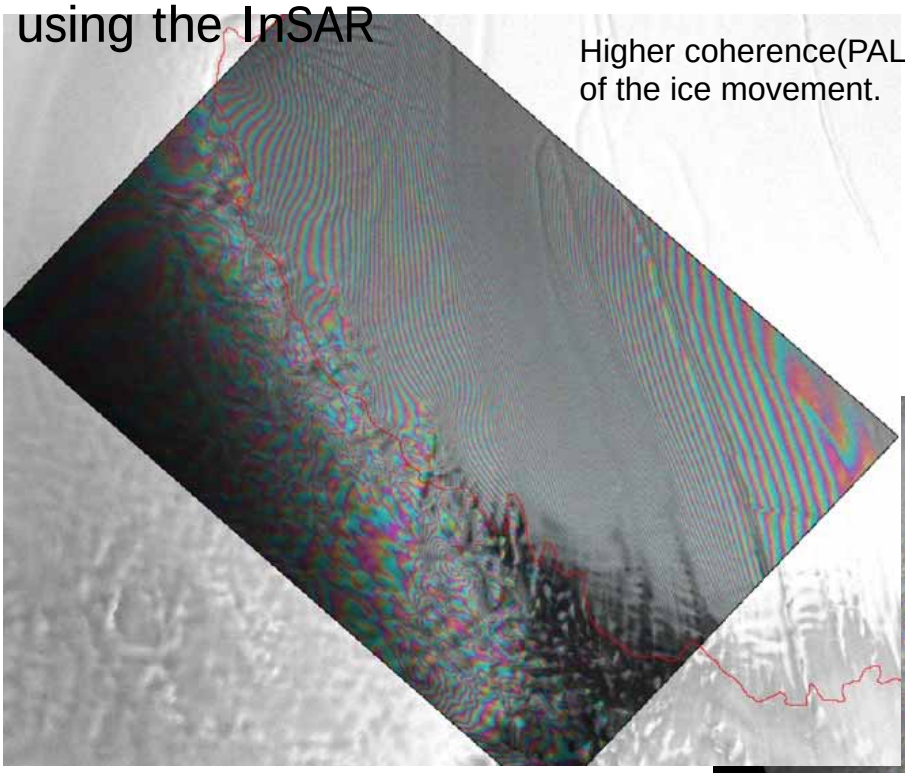
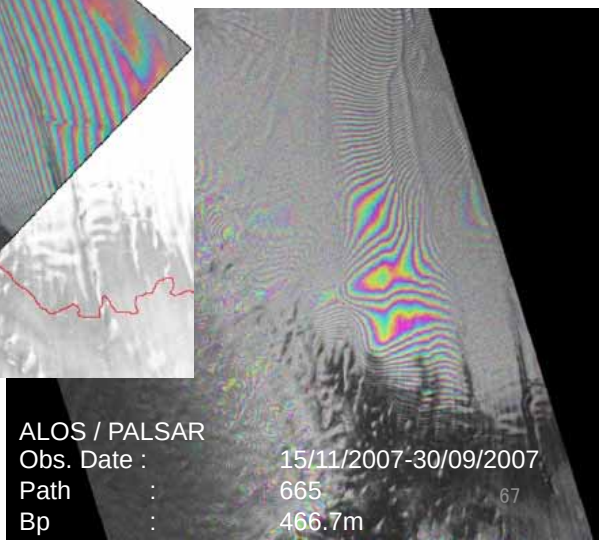
Detection of the ice sheet movement in the antarctica using the InSAR

Higher coherence(PALSAR-2) detects the details of the ice movement.



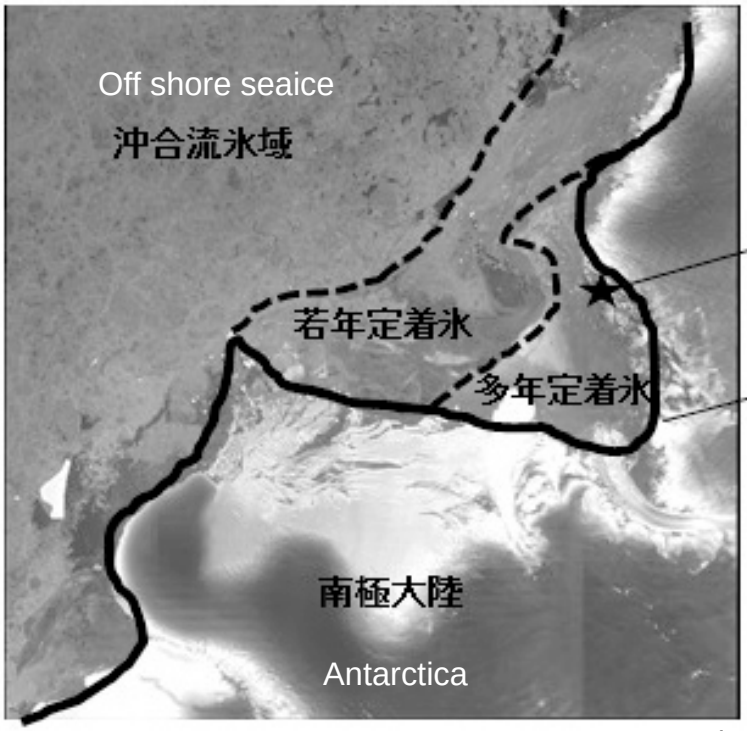
ALOS-2 / PALSAR-2
Obs. Date :23/08/2014-20/09/2014
Path :073
Frame :5020
Bp :-100.0m

Courtesy to Dr. Yamanokuchi



ALOS / PALSAR
Obs. Date : 15/11/2007-30/09/2007
Path : 665
Bp : 466.7m

Antarctica Observation



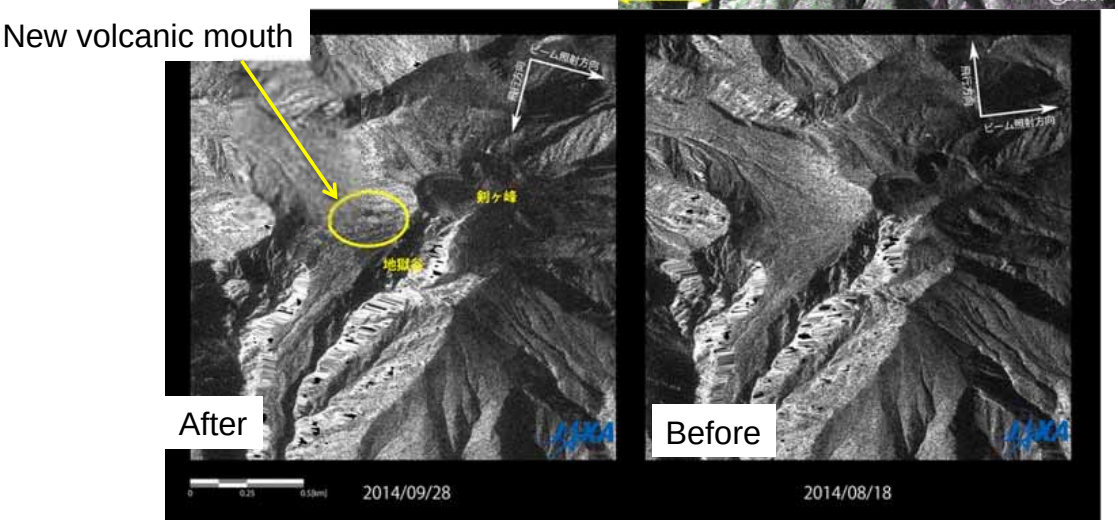
昭和基地
Syowa base

海岸線
Coast Lines

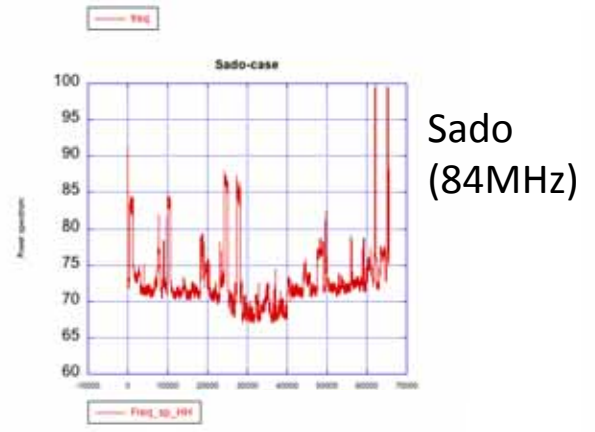
2014/11/28観測
PALSAR-2 VBD ScanSAR(490km)

Mt. Ontake eruption on Sept. 27 2014 and the emergency observation

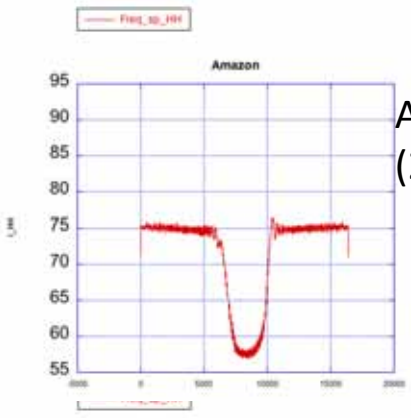
- Mt. Ontake erupted on 11:50 am, Sept. 27, 2014.
- Quick observations were activated within 12 hours for finding the change detections.
- New volcanic mouth and possible ash layers were detected.



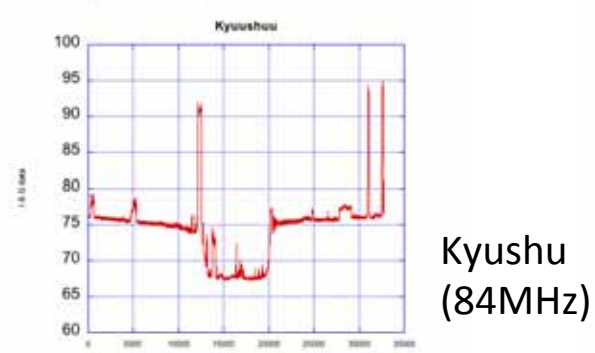
RFI measured in PALSAR-2 images



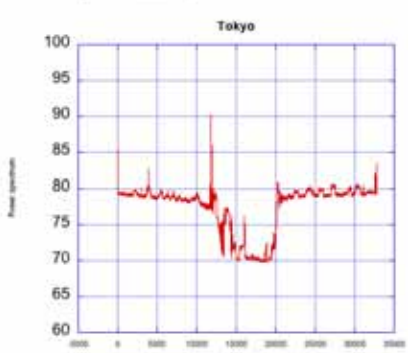
Sado (84MHz)



Amazon (28MHz)



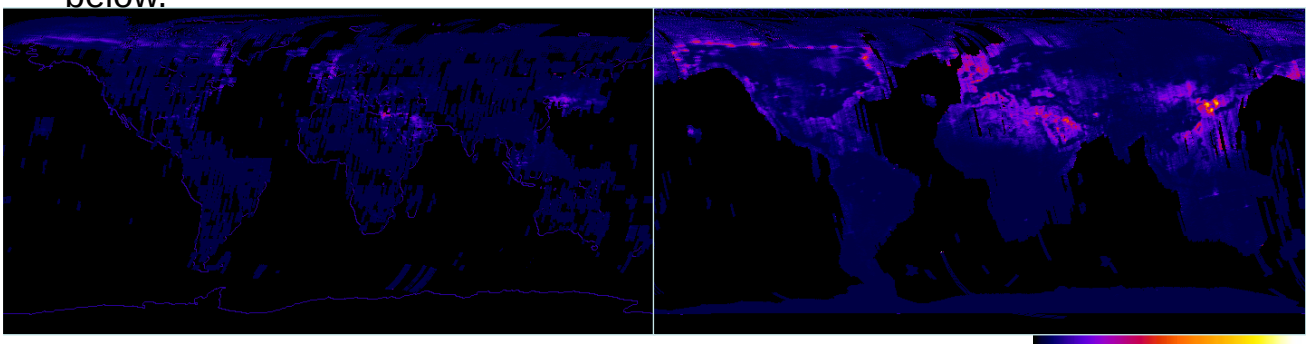
Kyushu (84MHz)



Tokyo(84MHz)

Global distribution of the RFI in L-band

- Degrades the SAR image quality when the RFI occurs in the SAR image.
- Compared withJERS-1/ALOS, ALOS-2 experiences bandwidth of 3-5MHz and 25 dB higher level of power than SAR signal.
- Spatio distribution of the RFI from JERS-1-SAR/ALOS-PALSAR is shown below.

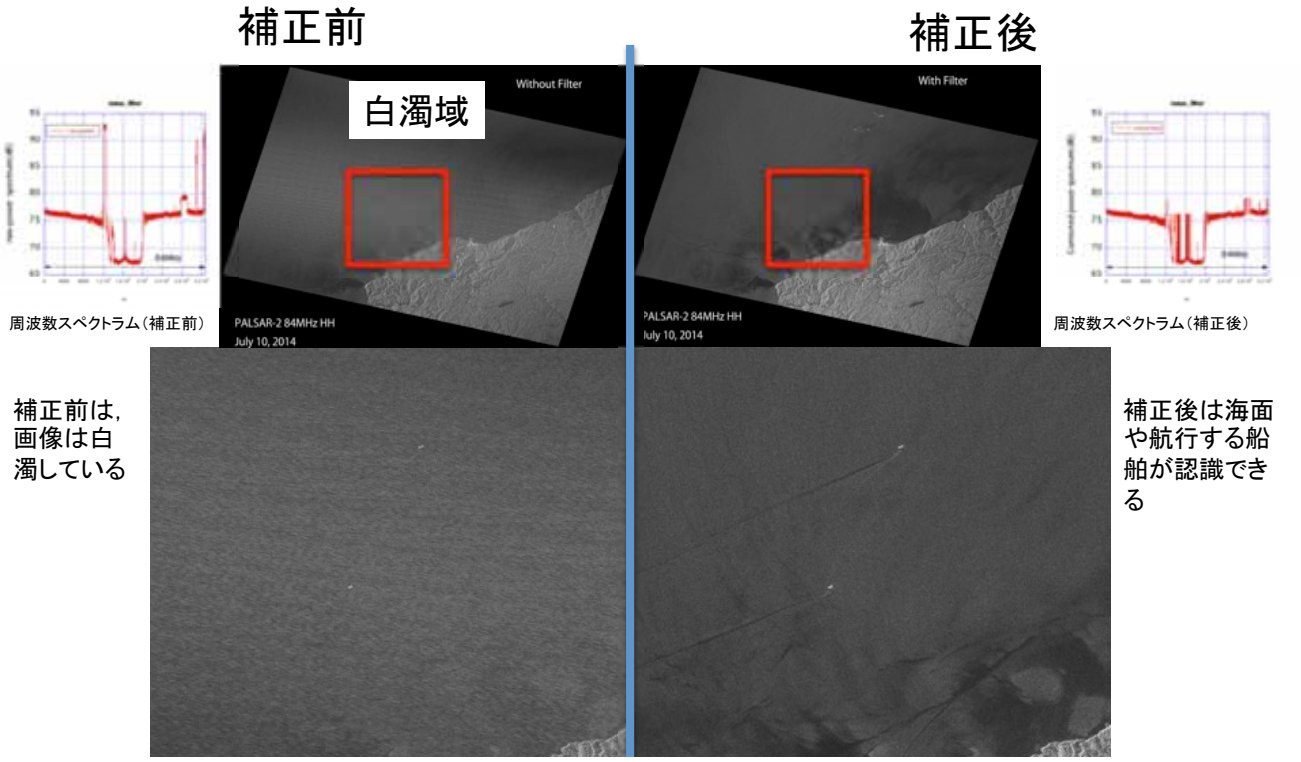


JERS-1 RFI　　PALSAR RFI

RFI increased significantly from JERS-1 and ALOS
1) Bandwidth
2) RFI bandwidth increases（100K->3M->5M)
3) RFI power increases（several dB-> 10dB->20dB）

→ RFI notch filter

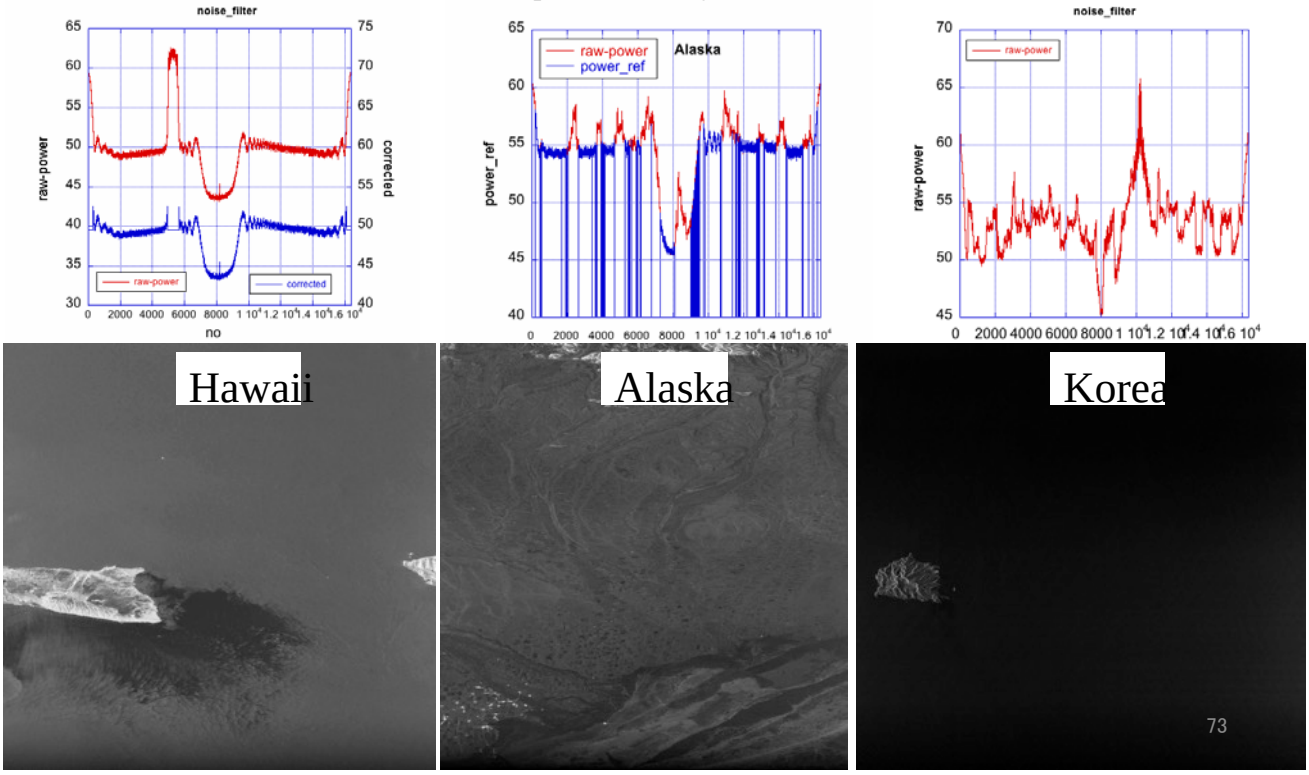
Degradation of the SAR images due to RFI and correction (i.e., Noto Peninsula, Wajima city)

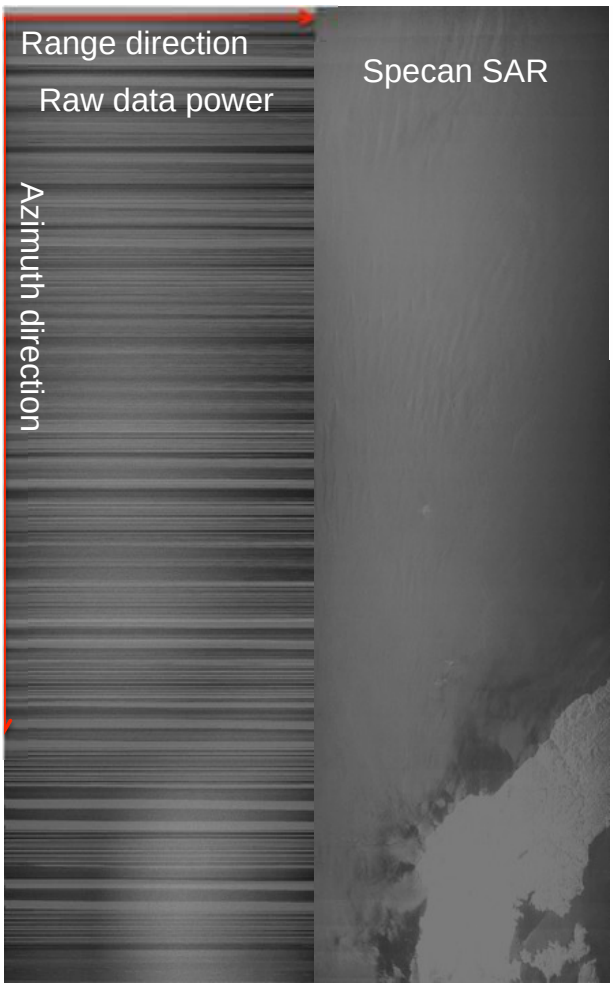


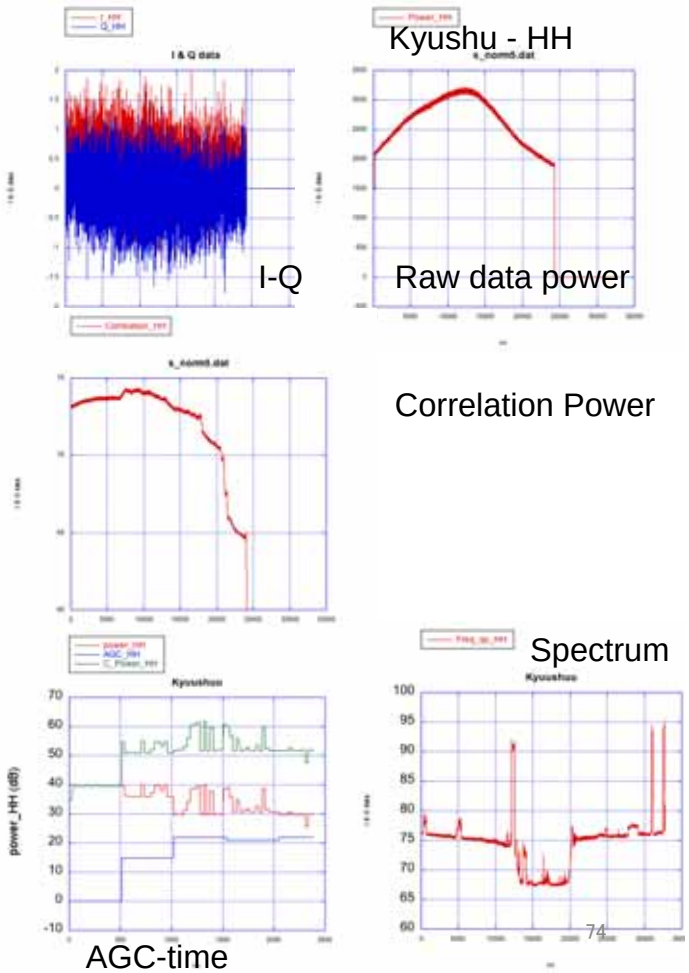
地上レーダ・携帯電話等からの信号がSAR信号に重畳し、画像が一部白濁する（左）。一方，不要波除去フィルターの挿入で画質は改善される（右）。（場所：能登半島、輪島市沖合）

RFI(PALSAR)

Max bandwidth is 3MHz band and power density difference is less than 12 dB







Raw data characteristics
Phase difference between I and Q channels

I/Q=, arg(I, Q) (deg)			I/Q, arg(I, Q)		
0.9993	90+1.5470	Sado	1.0014	90+1.5427	Amazon
1.0159	90+1.5479	Kyushu	0.9988	90+1.5520	Tokyo

Future activities and Conclusions

- ALOS-2/PALSAR-2 was successfully launched on May 24 2014 and now in the commissioning phase.
- In the initial calibration phase (Aug, 2~), the data will be carefully checked and calibrated.
- PALSAR-2 has four bandwidth of 84, 42, 28, 14 MHz, dual or full polarizations, in Strip, Spotlight, and ScanSAR mode.
- Initial calibration will be conducted using the calibration instruments, natural forest, and internal tuning of the software so that the data could be distributed to the users.
- 2BAQ gives higher data compression suffering in the noise increase. 4BAQ at least required for further operation.
- Range ambiguity seems to be less than the PALSAR and maintenance of the chirp works properly
- While the dual receiver is so powerful for obtain the wider imaging swath, adjusting the phase variation between them is key component for suppression of the azimuth ambiguity.
- Processor tuning for the other modes
- Radiometric and geometric calibration will start.

Basic Observation Scenario

Basic Observation Scenario (Global)

- Descending acquisitions (noon, ~12:00)
  - Global observations in Stripmap (3m SP) mode once per three years
  - Observations of Wetlands, Rapid Deforestation and Crustal Deformation in ScanSAR (350km DP) mode
  - Observations of Crustal Deformation and Forests *in Stripmap (10m DP) mode* during two successive cycles for InSAR applications

  (Super Sites)
  - Observations of *Boreal and sub-Arctic in ScanSAR (490km DP) mode*
  - InSAR observations of *Antarctica Glaciers in Stripmap (10m DP) mode*
- Ascending acquisitions (midnight, ~24:00)
  - Global observations in Stripmap (10m DP) mode twice per year
  - Observations of polar regions in ScanSAR (350km DP) mode three times per year to cover summer/winter seasons. Antarctica will be observed in left-looking mode to cover higher latitudes.
  - Global observations in Stripmap (6m QP) mode once per five years
  - Observations of special focus areas with Stripmap (6m QP) mode annually ***(Super Sites)***
  - InSAR observations of *Greenland Glaciers with Stripmap (10m DP) mode*

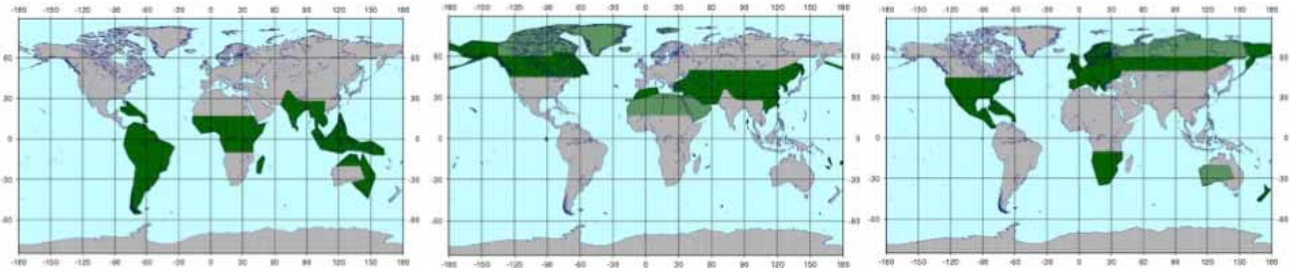
Basic Observation Scenario (Global)

Global land areas – VHR baseline mapping

Temporal repeat: 1 cov/ 3 years

GSD: 3 m (off-nadir 29.1°-38.2°)

Mode: Stripmap Single-pol（HH/84MHz）



1st year　　2nd year　　3rd year

Prio 1
Prio 2

* 3 years required for global coverage in 3m mode

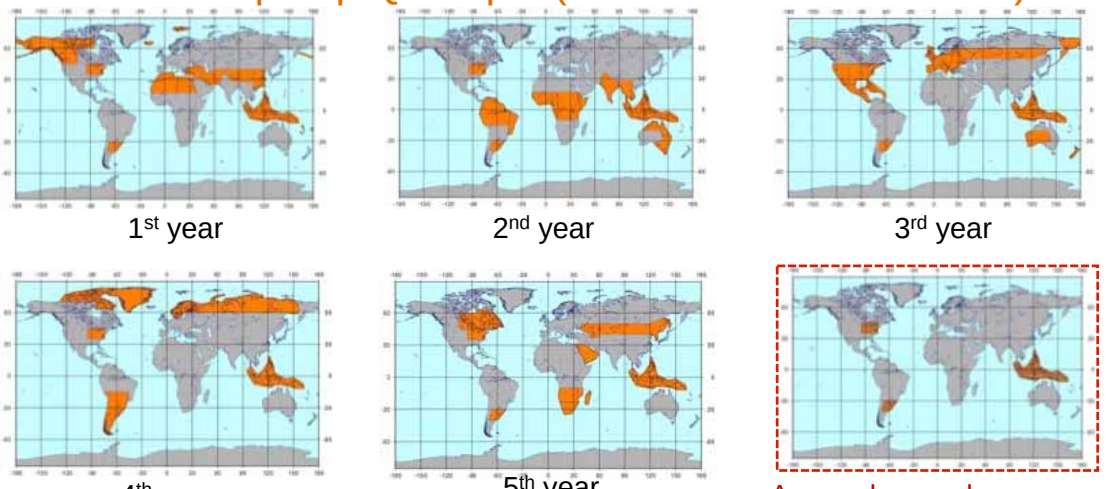
Basic Observation Scenario (Global)

Global land areas – Quad-polarimetric baseline

Temporal repeat: 1 cov/ 5 years

GSD: 6 m (off-nadir 25.0°-34.9°)

Mode: Stripmap Quad-pol (HH+HV+VV+VH/42MHz)



1st year　　2nd year　　3rd year

4th year　　5th year　　Areas observed every year

* 5 years required for global coverage in 6m QP mode

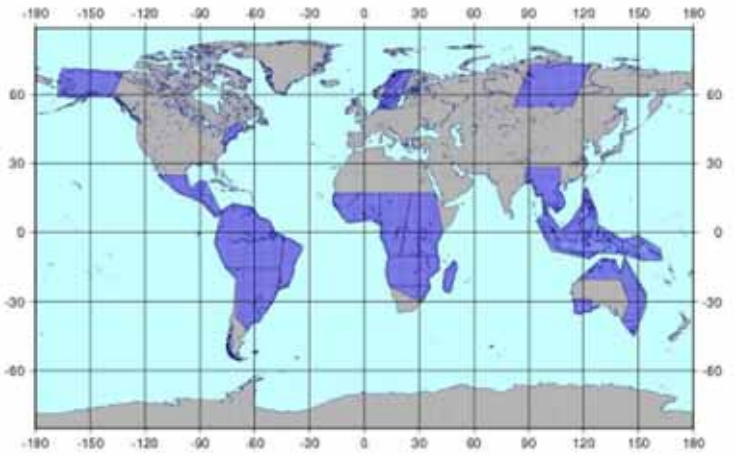
Basic Observation Scenario (Global)

Forest monitoring

Temporal repeat: 2-6 cov/year (tropics 6 cov)

GSD: 10 m (off-nadir 28.2°-36.2°)

Mode: Stripmap Dual-pol (HH+HV/28MHz)



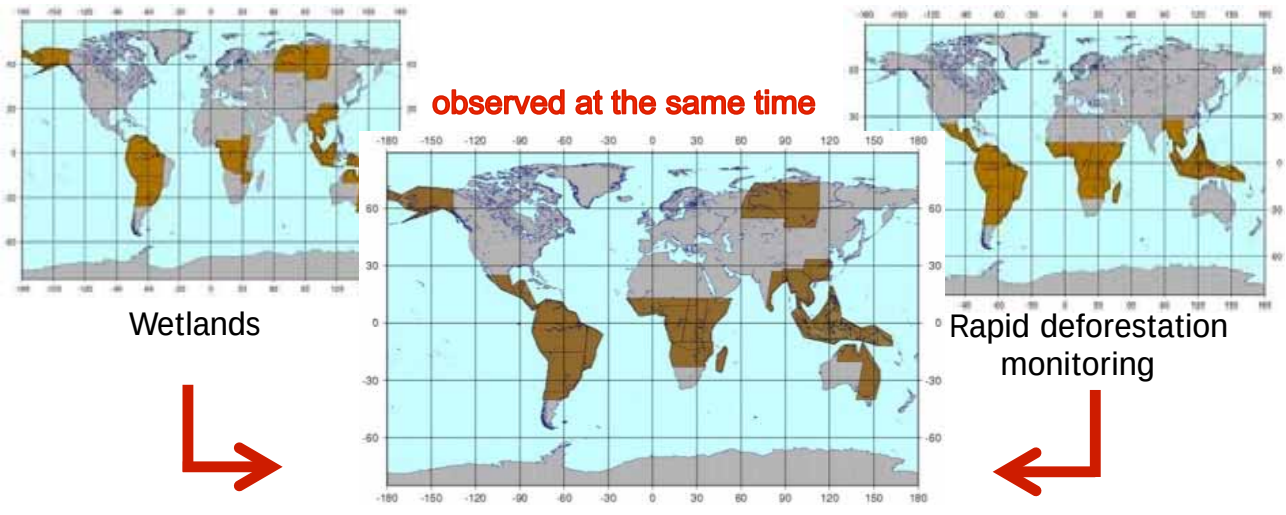
Basic Observation Scenario (Global)

Wetlands & Rapid deforestation monitoring

Temporal repeat: 9 cov/year

GSD: 100 m (off-nadir 26.2°-41.8°)

Mode: ScanSAR 350km Dual-pol (HH+HV/14MHz)



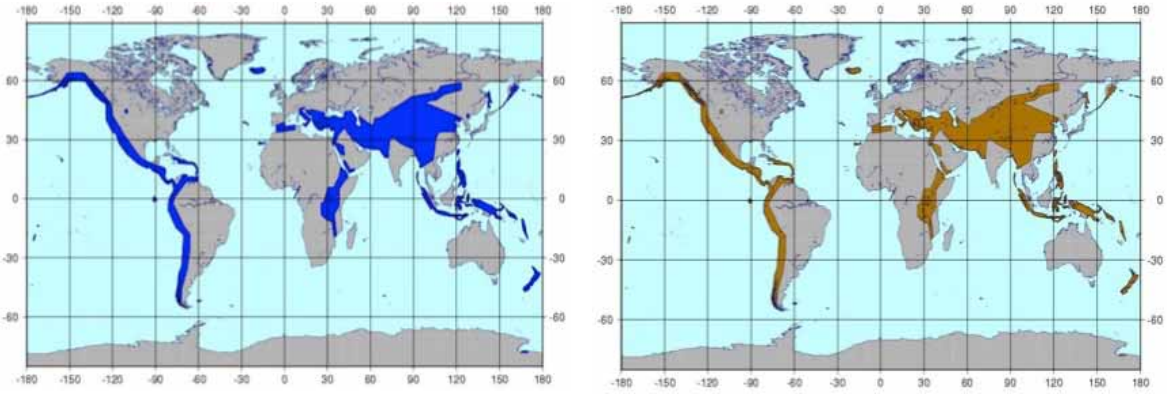
Basic Observation Scenario (Global)

Crustal Deformation

Temporal repeat: 2-6 cov/year & 9 cov/year

GSD: 10 m (off-nadir 28.2°– 36.2°)
& 100 m (off-nadir 26.2°– 41.8°)

Mode: Stripmap Dual-pol (HH+HV/28MHz)
& ScanSAR 350km (HH+HV/14MHz)



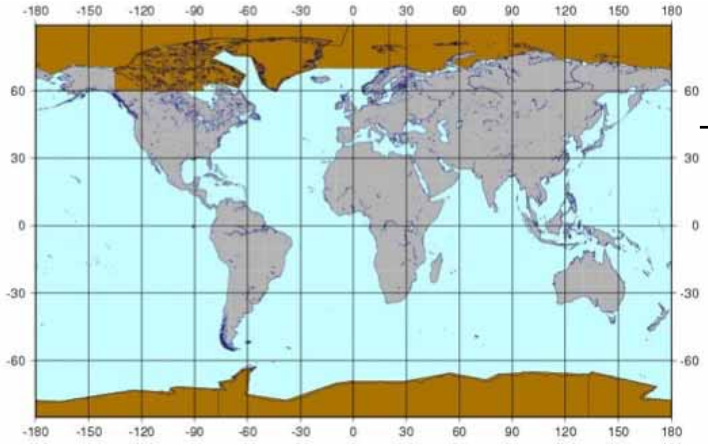
Basic Observation Scenario (Global)

Polar Ice

Temporal repeat: 3 cov/year

GSD: 100 m (off-nadir 26.2°– 41.8°)

Mode: ScanSAR 350km (HH+HV/14MHz)



Right looking

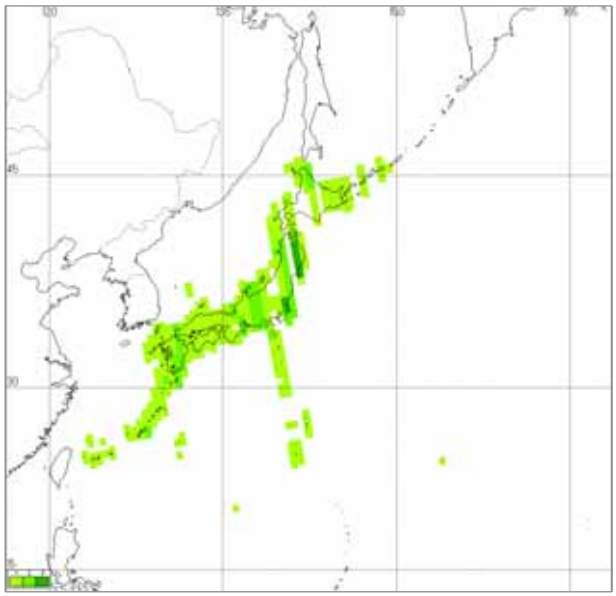
Left looking

Current Status of the data acquistion

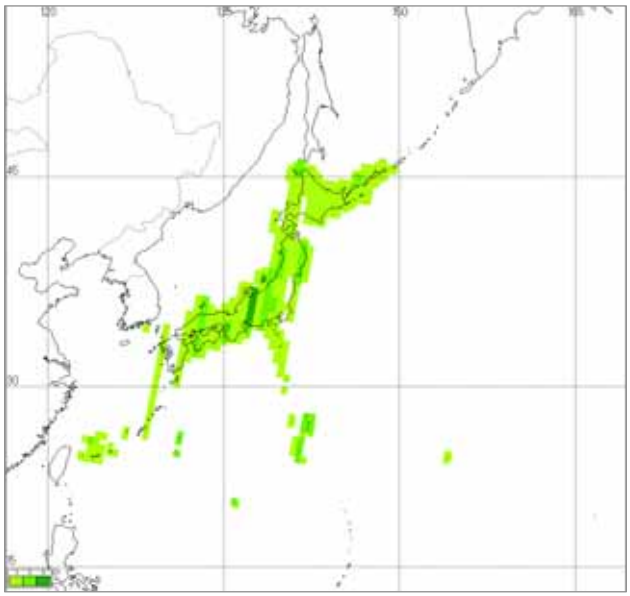
- Data aount acquired by now

BOS observation results（2014/8/4~2014/12/21）

日本域観測実績（高分解能3m/HH/84MHz）



U2-6～U2-9/右観測/昇交軌道
『災害ベースマップ』



U2-6～U2-9/右観測/降交軌道
『災害ベースマップ』

※未観測の陸域は2014/11/24～2015/2/15の期間でリカバリ予定

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BOS observation results（2014/8/4~2014/12/21）

日本域観測実績（広域観測350km/28MHz）

W2/右観測/昇交軌道
『災害ベースマップ』

W2/右観測/降交軌道
『災害ベースマップ』

※未観測の陸域は2015/2/2～2/15の期間でリカバリ予定

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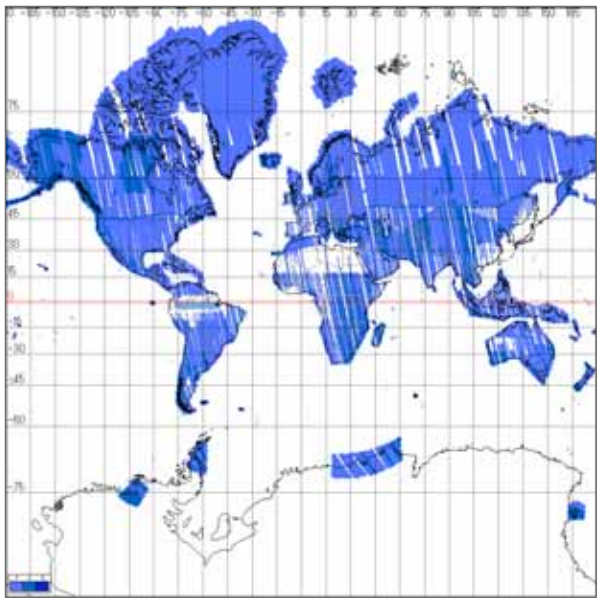
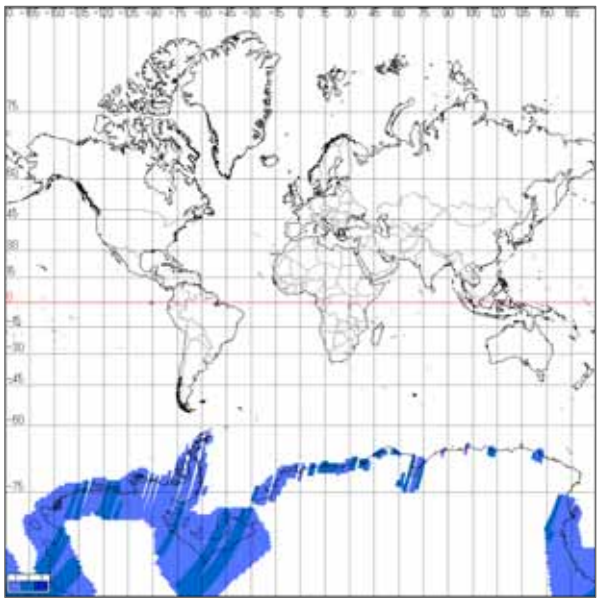
別紙4

BOS observation results（ 2014/8/4~2014/12/21 ）

世界域観測実績（高分解能10m/28Mhz）



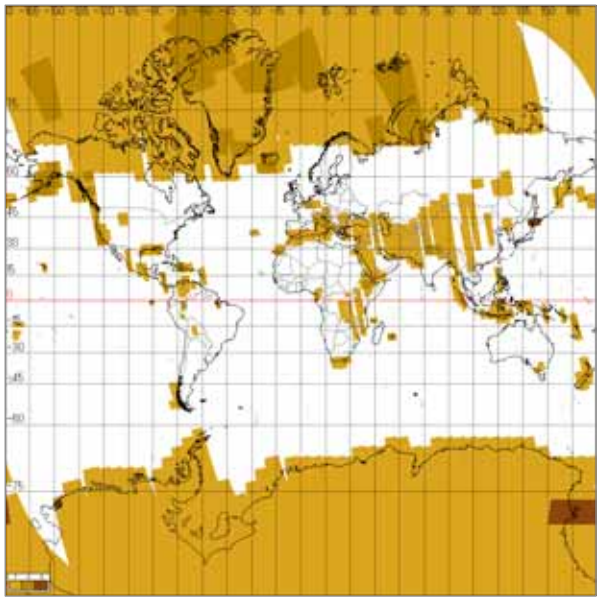
F2-5~F2-7/右観測/昇交軌道/HH+HV
『グローバル観測』



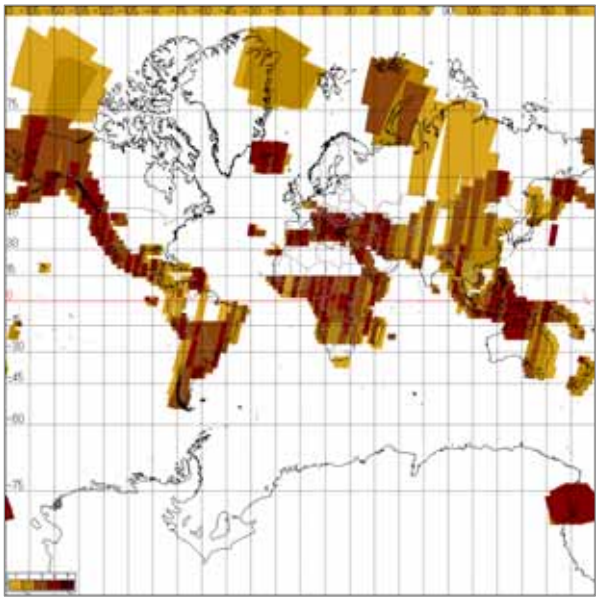
F2-6/左観測/降交軌道/HH
『スーパサイト/氷河流動モニタリング』

BOS observation results（ 2014/8/4~2014/12/21 ）

世界域観測実績（広域観測350km/14Mhz/HH+HV）



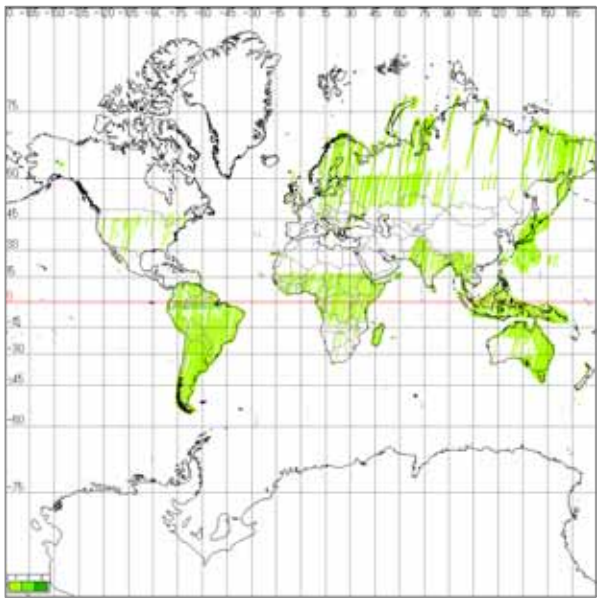
W2/右（北極）・左（南極）/昇交軌道
『極域観測』



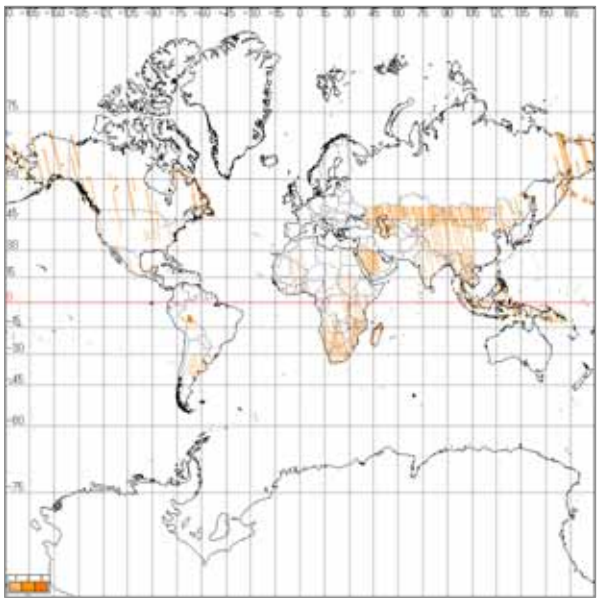
W2/右観測/降交軌道
『地殻変動、湿地、伐採』

BOS observation results（ 2014/8/4~2014/12/21 ）

世界域観測実績（高分解能3m/6m）

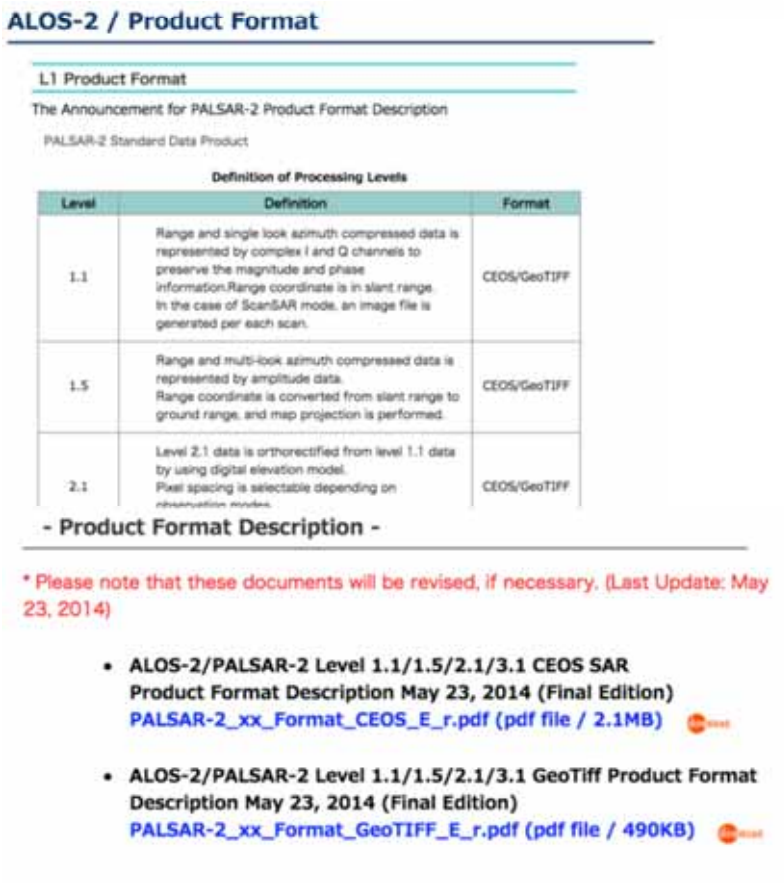


U2-6~9/右観測/降交軌道/HH/84MHz
『グローバル観測/その他』



FP6-3~7/右観測/昇交軌道/HH+HV
+VH+VV/42MHz
『グローバル観測/その他』

Product List



ALOS-2 / Product Format

L1 Product Format

The Announcement for PALSAR-2 Product Format Description

PALSAR-2 Standard Data Product

Definition of Processing Levels

Level	Definition	Format
1.1	Range and single look azimuth compressed data is represented by complex I and Q channels to preserve the magnitude and phase information.Range coordinate is in slant range. In the case of ScanSAR mode, an image file is generated per each scan.	CEOS/GeoTIFF
1.5	Range and multi-look azimuth compressed data is represented by amplitude data. Range coordinate is converted from slant range to ground range, and map projection is performed.	CEOS/GeoTIFF
2.1	Level 2.1 data is orthorectified from level 1.1 data by using digital elevation model. Pixel spacing is selectable depending on	CEOS/GeoTIFF

- Product Format Description -

* Please note that these documents will be revised, if necessary. (Last Update: May 23, 2014)

- **ALOS-2/PALSAR-2 Level 1.1/1.5/2.1/3.1 CEOS SAR Product Format Description May 23, 2014 (Final Edition)**
  PALSAR-2_xx_Format_CEOS_E_r.pdf (pdf file / 2.1MB)
- **ALOS-2/PALSAR-2 Level 1.1/1.5/2.1/3.1 GeoTiff Product Format Description May 23, 2014 (Final Edition)**
  PALSAR-2_xx_Format_GeoTIFF_E_r.pdf (pdf file / 490KB)

JAXA related Site

Product

http://www.eorc.jaxa.jp/ALOS/en/index.htm

Use Data

http://www.eorc.jaxa.jp/ALOS-2/en/doc/pal2_tool.htm

ALOS-2 observation strategy

http://www.eorc.jaxa.jp/ALOS/en/top/obs_top.htm

Conclusions

- PALSAR-2 shows the 13 dB of SNR, 5 dB larger than PALSAR and very small saturation.
- Radiometric and geometric performances of all the modes (SL, UB, HB, FB, WB, and VB) meet the mission requirements (i.e., 0.4 dB radiometry, 5.34 RMSE of geometry, quite low NESZ, resolution of all the modes, cross talk of the polarimetry of -40 dB)
- Interferometry performance, polarimetric performance were confirmed and deformation detection could be conducted.
- Initial Calibration of the PALSAR-2 has been successfully conducted(Nov. 20, 2014) and the data distribution has been started.
- ALOS-2 observation phase has started for the global observation based on BOS on Aug. 20, 2014.
- Polar regions were well covered. The forest region is not fully covered for 2014 (50%).
- Daily data acquisition is 800 GB.
- RFI is the biggest issue of the L-band SAR image quality.
- Ionospheric issue will be considered the further investigation