# Orthorectified Mosaic for Asia and Australia

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K&C 10 at RESTEC HQ
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Contents of talk

- Path Processing of the all the SAR modes (FBS, FBD, POL, SCAN)
- Ortho-rectification of the path products
- Mosaicking
- Geometric evaluation and radiometric equalization
- Conclusion

Algorithms

- Slant range path products (~thousand km for STRIP and SCAN)
  - Segmented (16K) Doppler parameters and antenna pattern
  - Averaging with 16 look in azimuth and 4 look in range
  - Small segment based interference suppression
  - Small segment based saturation correction
  - Multi PRF imaging based on the motion compensation
  - Antenna pattern normalization based on the Amazon

- Geo-referenced ortho path data using the SRTM DEM
  - Precise matching using the segmented Doppler
  - Time shift tuning in Az. and Rg.
  - Projection from the slant range to ground range ortho path

- Mosaicking process
  - Normalization of the $\sigma^0$ or conversion to $\gamma^0$
  - Pasting the above path data on a campus
  - Geo-coding it to the final coordinates

# STRIP mode imaging (Radiometry)

- Raw data scaling

$$\mathbf{v}_{raw}^{i,j} = \frac{1}{\sqrt{G_{MGC}(T)\cdot\left(P_t/\overline{P}_t\right)}\{1-S_a(t,T)\}}\left[\left(\mathbf{v}-\overline{\mathbf{v}}\right)\frac{\sigma_l}{\sigma_q}\right]^{i,j} E^{i,j}$$

$$E = \begin{pmatrix} \sigma_V/\sigma_H & 0 \\ 0 & 1 \end{pmatrix}$$

- Antenna Correction (Before azimuth correlation)

$$\overline{\mathbf{V}}_{rg}^{i,j} = \frac{R\sqrt{\sin\theta_{inci}}}{G_{ele}^{i,j}\left(\phi_{off},beam\right)}\mathbf{V}_{rg}^{i,j}$$

- Power

$$P_{i,j} \cong a\frac{G_{\mathbf{ele}}^{\mathbf{2}}}{R^2\sin\theta_{inci}}\sigma_{i,j}^{0} + N_{i,j}$$

- POL mode

$$\mathbf{S}_{ij} = \mathbf{R}^{-1}\cdot\mathbf{Z}_{ij}\cdot\mathbf{T}^{-1}$$

i, j : transmission and reception pol.
Noise is not subtracted.

$v_{raw}$:raw data voltage
$v_{rg}$ : volt after range corr.
p : power
S:caled scattering matrix
Z : uncal scattering matrix

R : slant range
$\theta_{inci}$ : incidence angle
$\phi_{off}$ : off nadir angle
$\sigma^0$ : sigma-naught

Calibration target
$G_{ele}$ : antenna pattern
R,T : distortion matrix
a : coefficients

# SCAN mode imaging (Radiometry)

Raw data scaling

$$\mathbf{v}_{raw}^{i,j} = \frac{1}{\sqrt{G_{MGC}(T)\cdot\left(P_t/\overline{P}_t\right)\cdot\left\{1-S_a(t,T)\right\}}}\left[\left(\mathbf{v}-\overline{\mathbf{v}}\right)\frac{\sigma_l}{\sigma_q}\right]^{i,j} E^{i,j}$$

$$E = \begin{pmatrix} \sigma_V/\sigma_H & 0 \\ 0 & 1 \end{pmatrix}$$

Antenna Correction (Before azimuth SPECAN)

$$\overline{\mathbf{V}}_{rg}^{i,j} = \frac{R\sqrt{\sin\theta_{inci}}}{G_{ele}^{i,j}\left(\phi_{off},beam\right)}\mathbf{V}_{rg}^{i,j}$$

Power

$$P_{i,j} \cong a\frac{G_{\mathbf{ele}}^{\mathbf{2}}\cdot N_{az}^{2}}{R^{4}\sin\theta_{inci}}\sigma_{i,j}^{0} + N_{i,j}$$

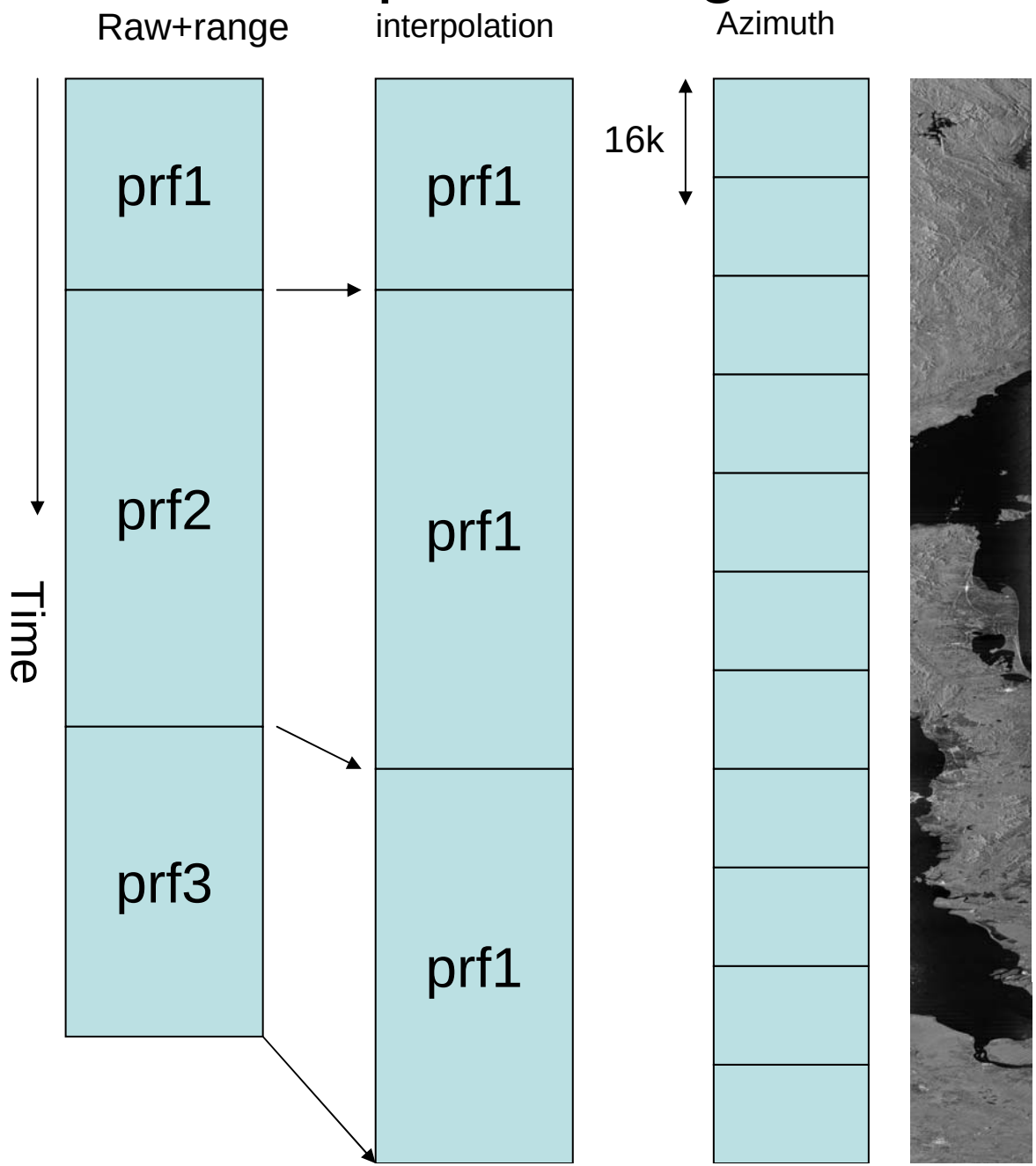
$v_{raw}$:raw data voltage
$v_{rg}$ : volt after range corr.
p : power
S:caled scattering matrix
Z : uncal scattering matrix

R : slant range
$\theta_{inci}$ : incidence angle
$\phi_{off}$ : off nadir angle
$\sigma^0$ : sigma-naught

Calibration target
$G_{ele}$ : antenna pattern
R,T : distortion matrix
a : coefficients

i, j : transmission and reception pol.
Noise is not subtracted.

# Multi PRF processing

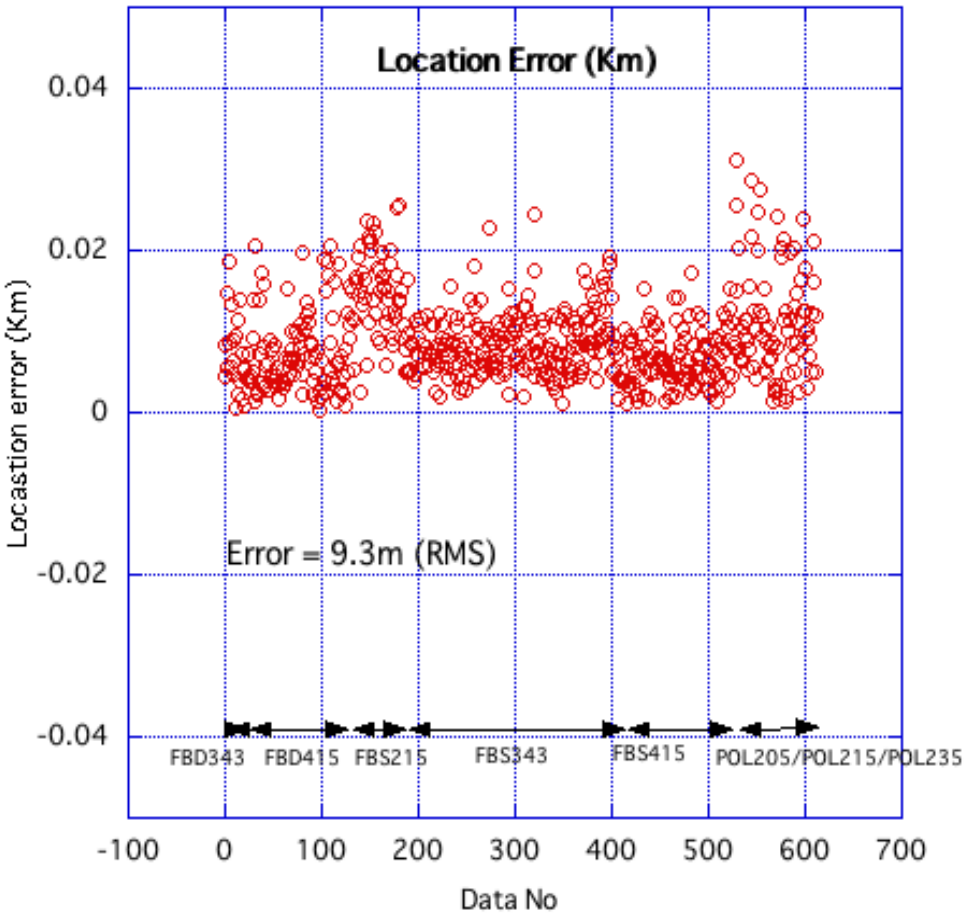


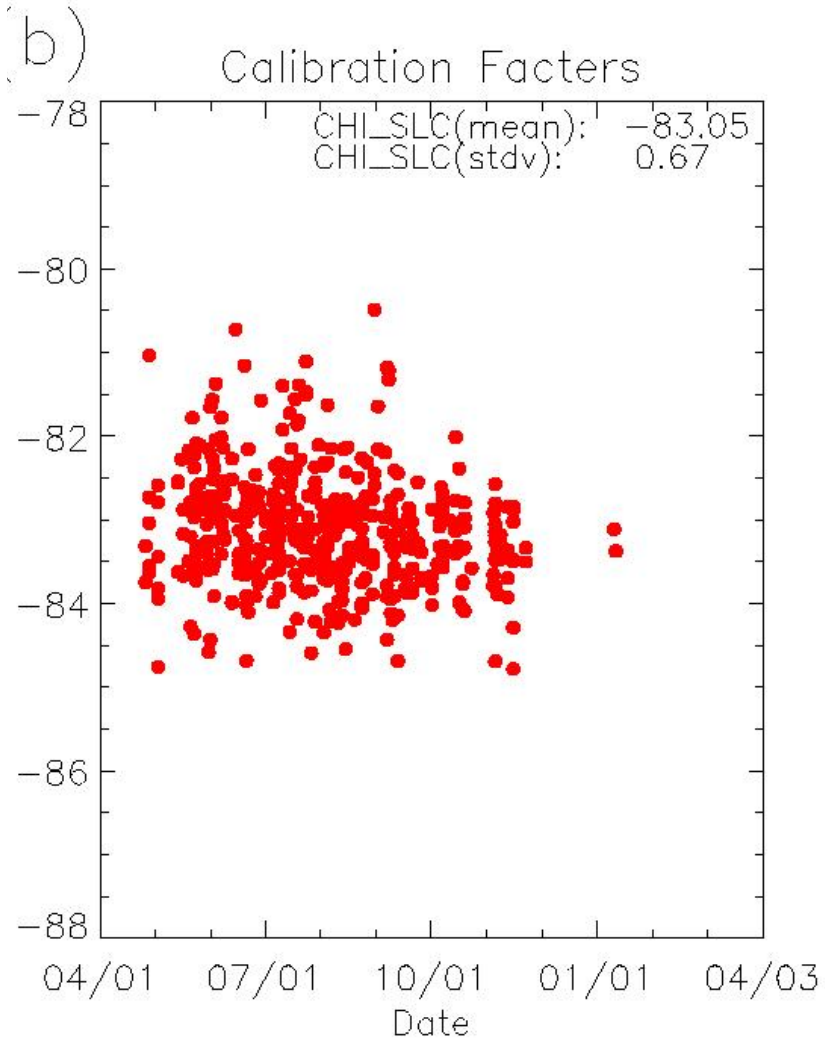

8th order sinc interpolation for complex

$$f(x) = \sum_{i=0}^{7} g(x_i) \frac{sin(x - x_i)}{x - x_i}$$

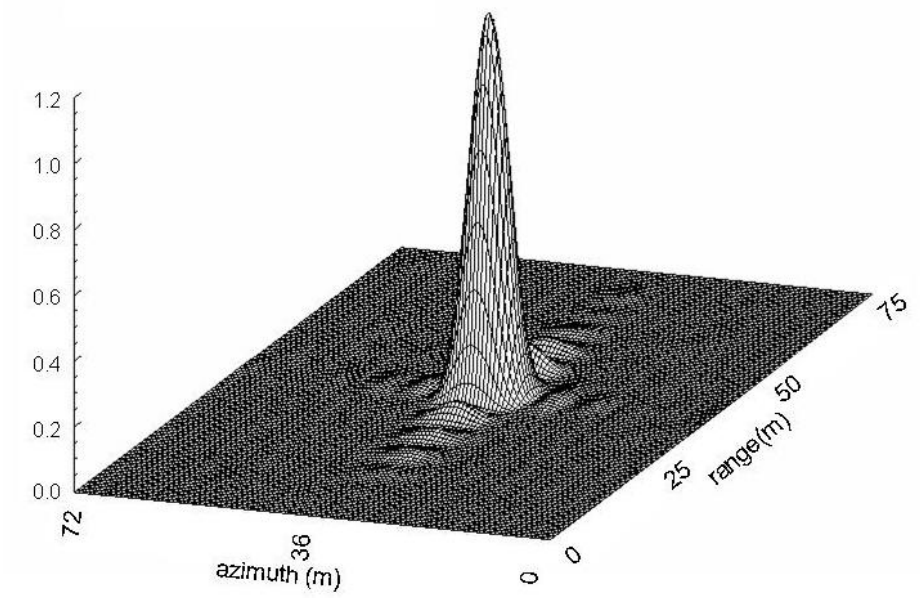
Prf changes up to 7 times in descending or ascending node

# Geo-locations and Calibration factors

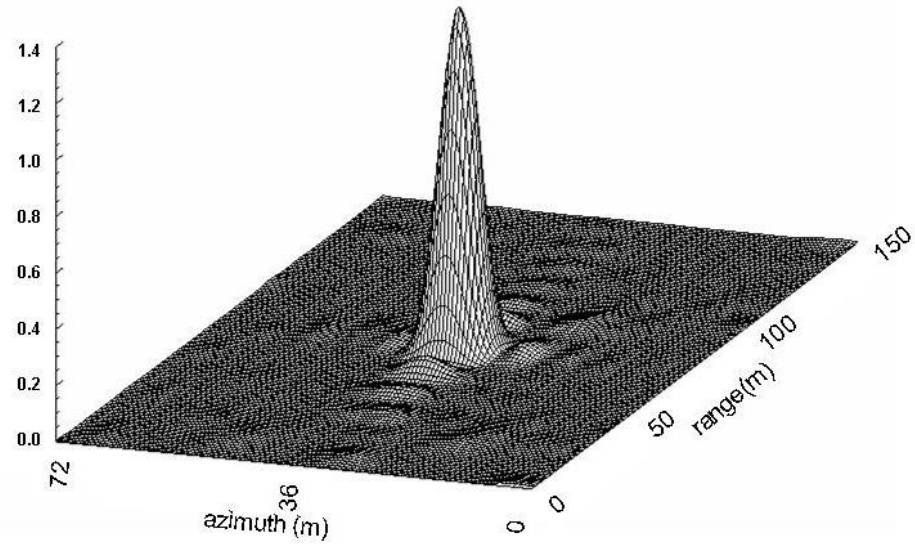


# IRF

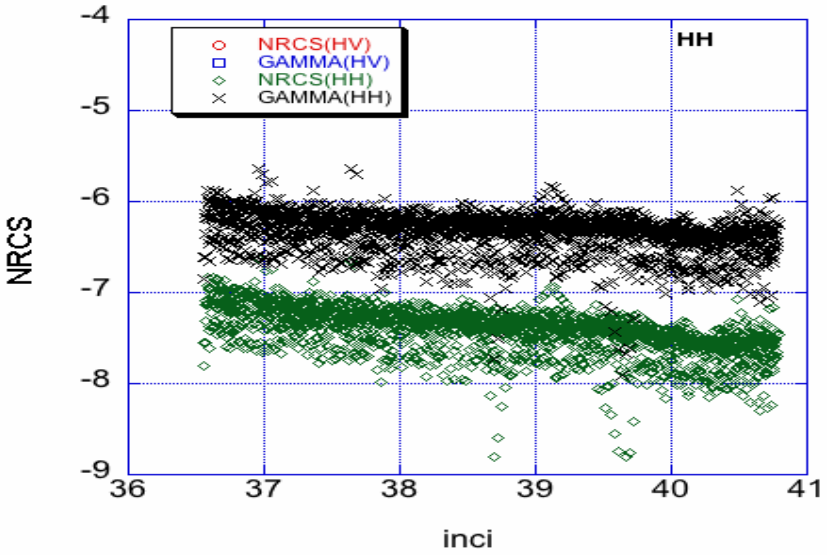


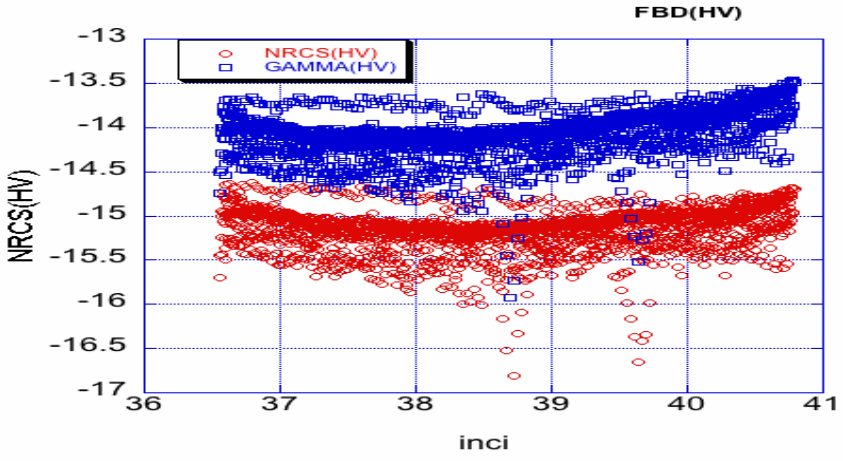

FBS34.3H
20060427/Watarase_J04



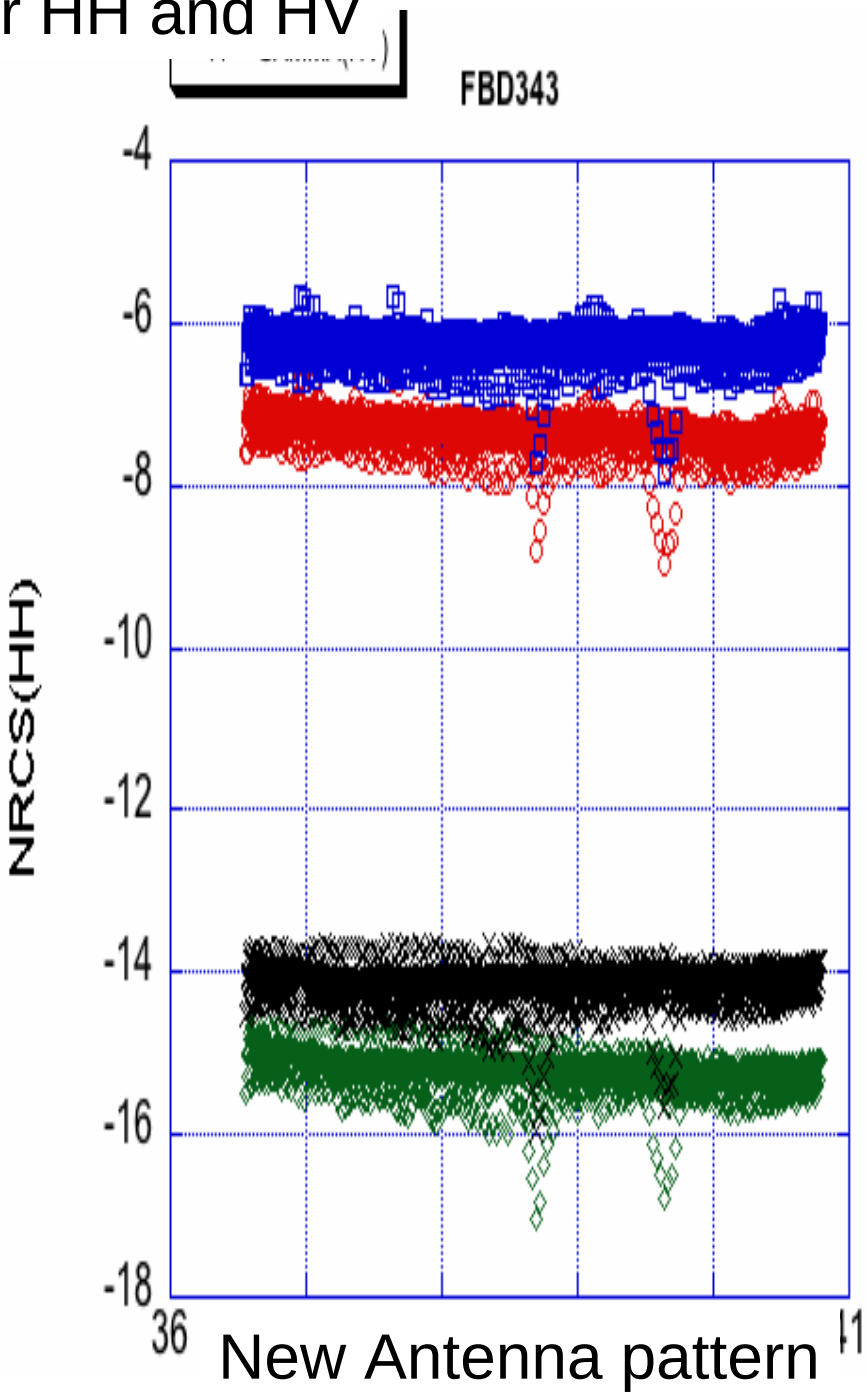

FBD34.3H
20060728/Tomakomai J03

# GAMMA-naught vs. incidence for HH and HV



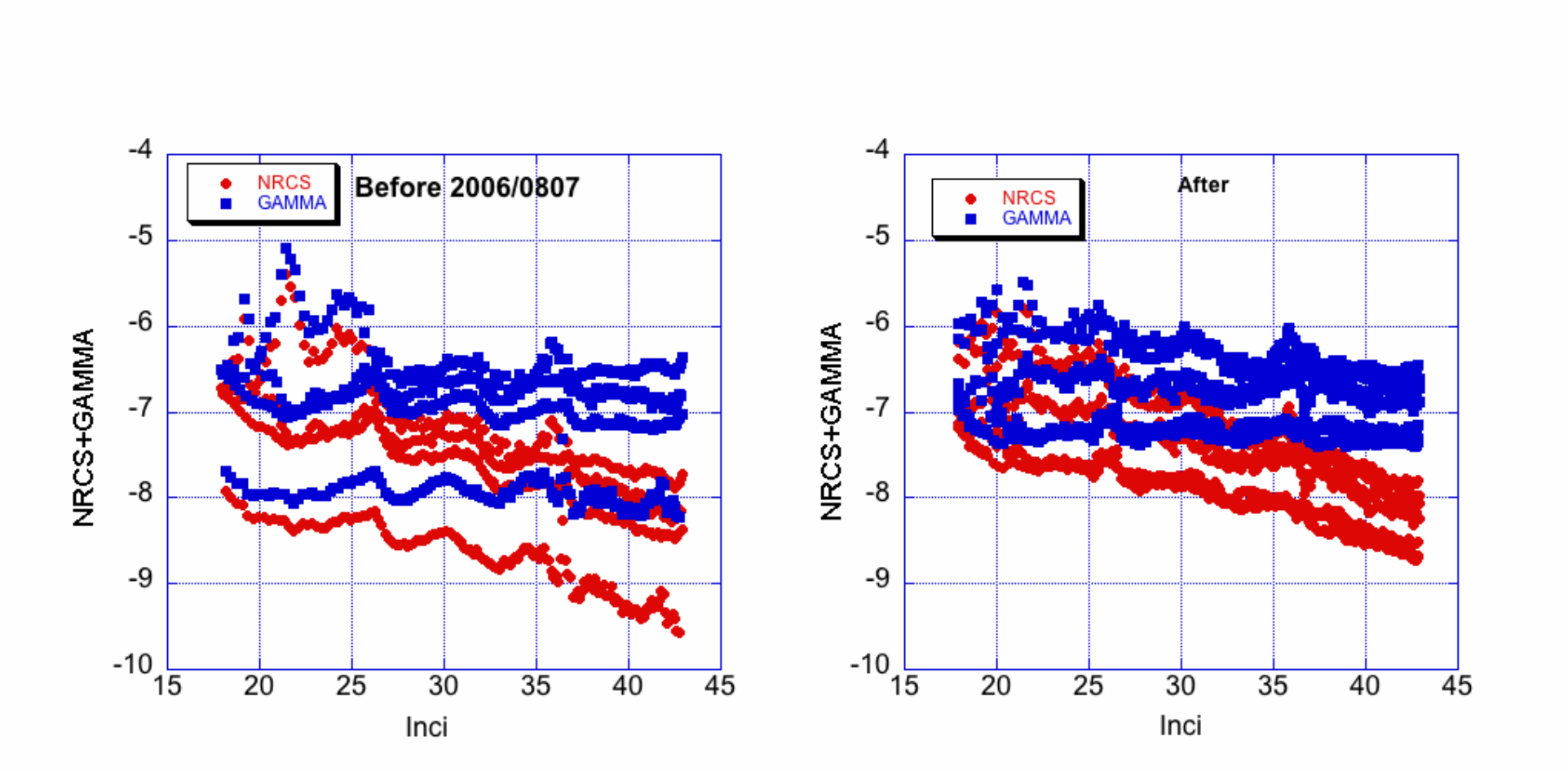




Old Antenna pattern




New Antenna pattern

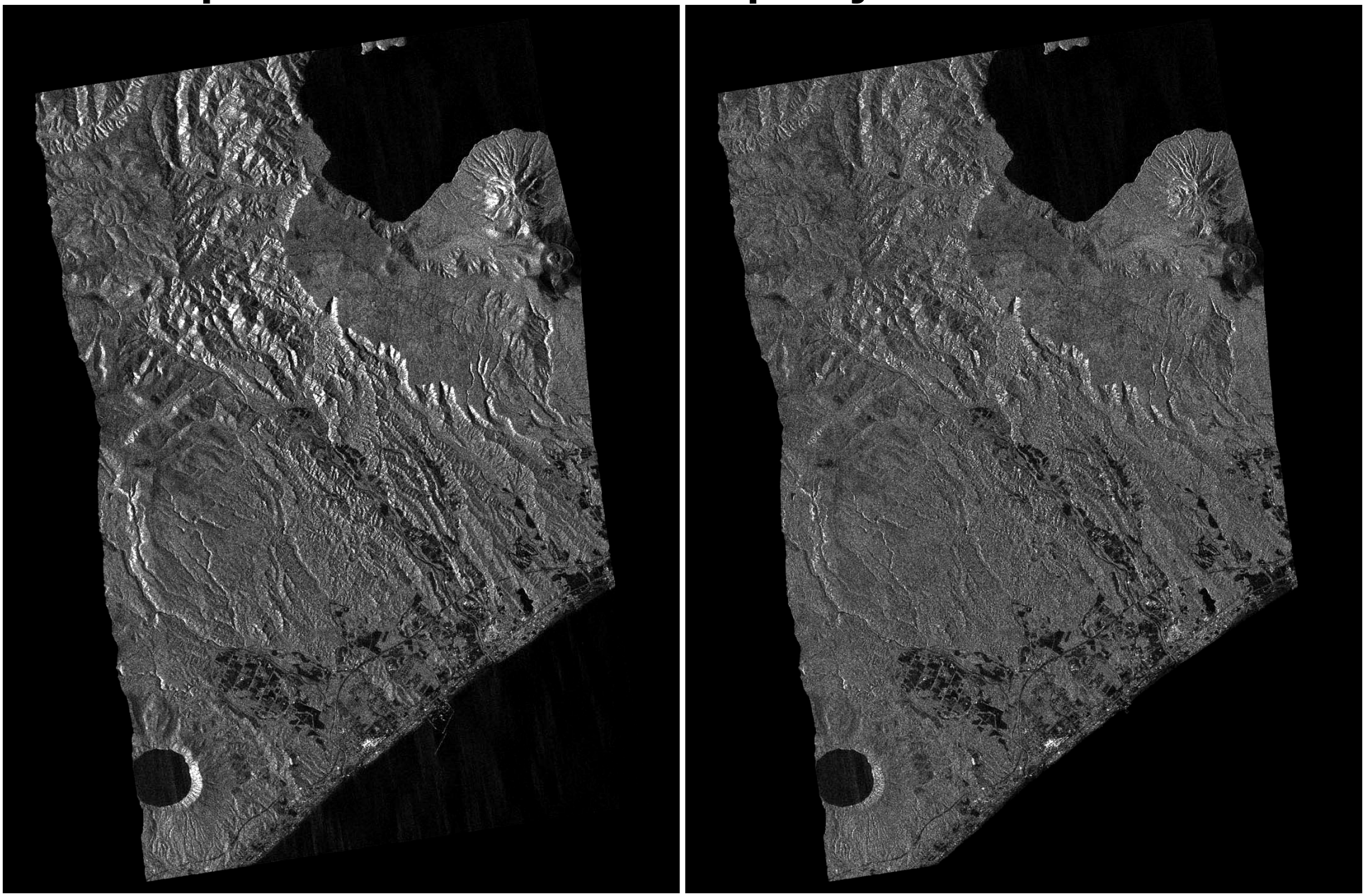
# GAMMA and SIGMA vs. incidence angle




Before Aug. 7 2006

After Aug. 7 2006

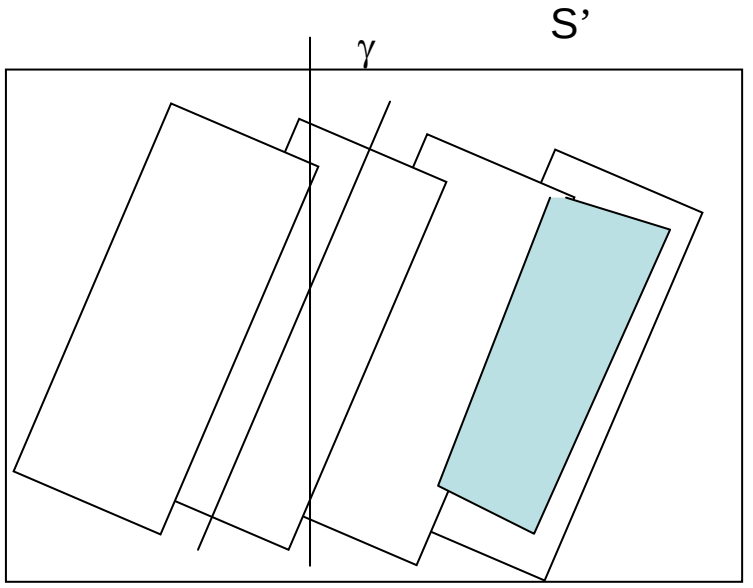
# Comparison of ortho projections



Map projection

# Several maps are avilable(Mercator, LCC, equal lat-lon, PS, UTM)

Here
S: Mercator coordinate
Ra:radius of equator、Rb: polar radius
Λ:londitude,ψ:geodetci lattitude,ϕ:geocentric latitude
E:eccentricity




New cordinate suing the emean inclination(γ)’

$$\mathbf{S}' = \begin{pmatrix} \cos\gamma & \sin\gamma \\ -\sin\gamma & \cos\gamma \end{pmatrix}(\mathbf{S} - \mathbf{S}_c) + \mathbf{S}_c$$

$$\mathbf{S} = \begin{pmatrix} R_a\lambda,\ R_a \ln\tan\left(\frac{\pi}{4} + \frac{\varphi}{2}\right)\left(\frac{1 - e\sin\varphi}{1 + e\sin\varphi}\right)^{\frac{e}{2}} \end{pmatrix}$$

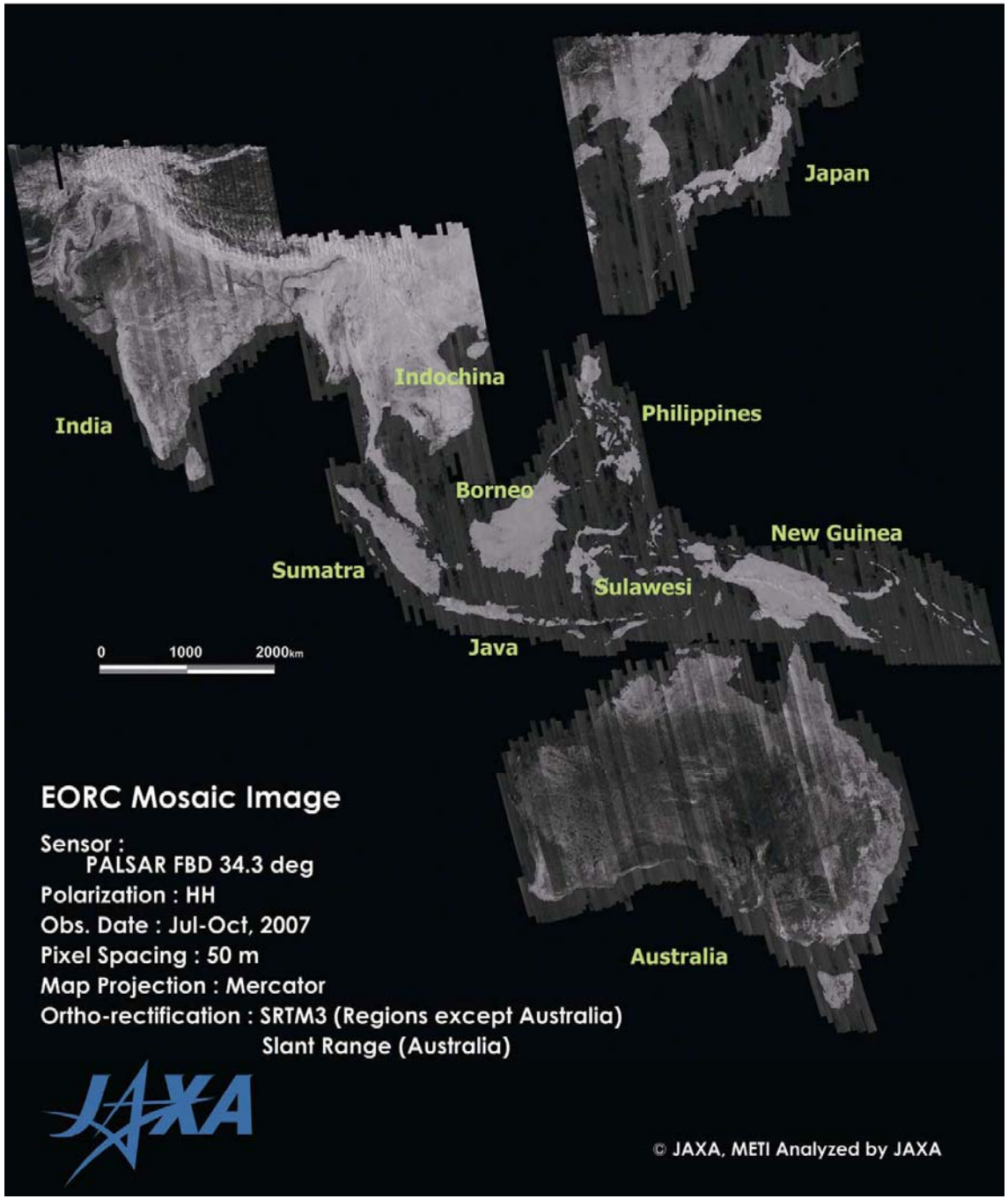
Final coordinate:S

Geodetic lat and lon

$$\begin{pmatrix} \varphi \\ \lambda \end{pmatrix} = \begin{pmatrix} \tan^{-1}\left(R_a^2 / R_b^2 \cdot \tan\phi\right) \\ \lambda \end{pmatrix} = \begin{pmatrix} \tan^{-1}\left(R_a^2 / R_b^2 \cdot z_g / \sqrt{x_g^2 + y_g^2}\right) \\ \tan^{-1}\left(y_g / x_g\right) \end{pmatrix}$$

# PALSAR Mosaic for Japan, South-East Asia, India, Australia

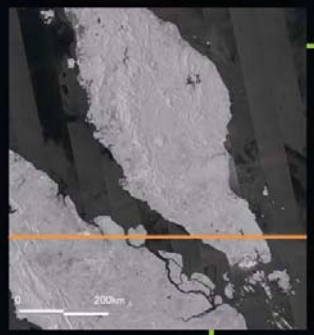
Japan Aerospace Exploration Agency, Earth Observation Research Center



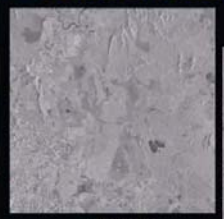
# Kyoto and Carbon Project-A Global forest and environmental monitoring using ALOS PALSAR

Japan Aerospace Exploration Agency, Earth Observation Research Center

Sensor : PALSAR
Mode: FBD 34.3HH
Orbit: RSP433~455
Obs. Date : June-July, 2007
Map Projection : EQR
Ortho-rectification : SRTM3



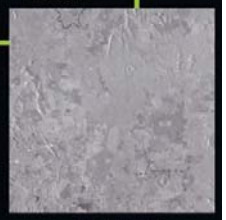

Pasoh Forest area



JERS 1993

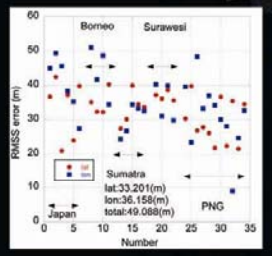
JERS 1998

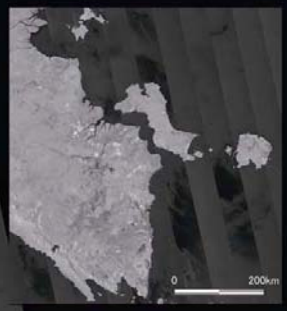
NRCS
−35db
−5db



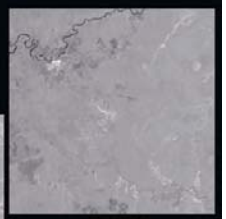
PALSAR 2007

0 500km




As the reference dataset by the ALOS Kyoto and carbon initiative project, two datasets are being created, i.e., 1) global 50 meter ortho-rectified mosaic, and 2) 500 meter pixel spaced browse mosaic product. Former product is created from the ascending path for dry and wet seasons or summer and winter seasons globally, and the latter is created as the quick look mosaic for visually checking the images acquired. Except for the resolution, both images can be converted to the normalized radar cross section in decibel. These images can be updated to this home page as they are created and they can be visualized by the following methods. The main purpose of the ALOS Kyoto and Carbon initiatives are to interpret the forest originated carbon quantity and its changes, and monitors the global land changes for forest, wetland, and desert area. Using this home page, the current earth environmetal change can be observed.

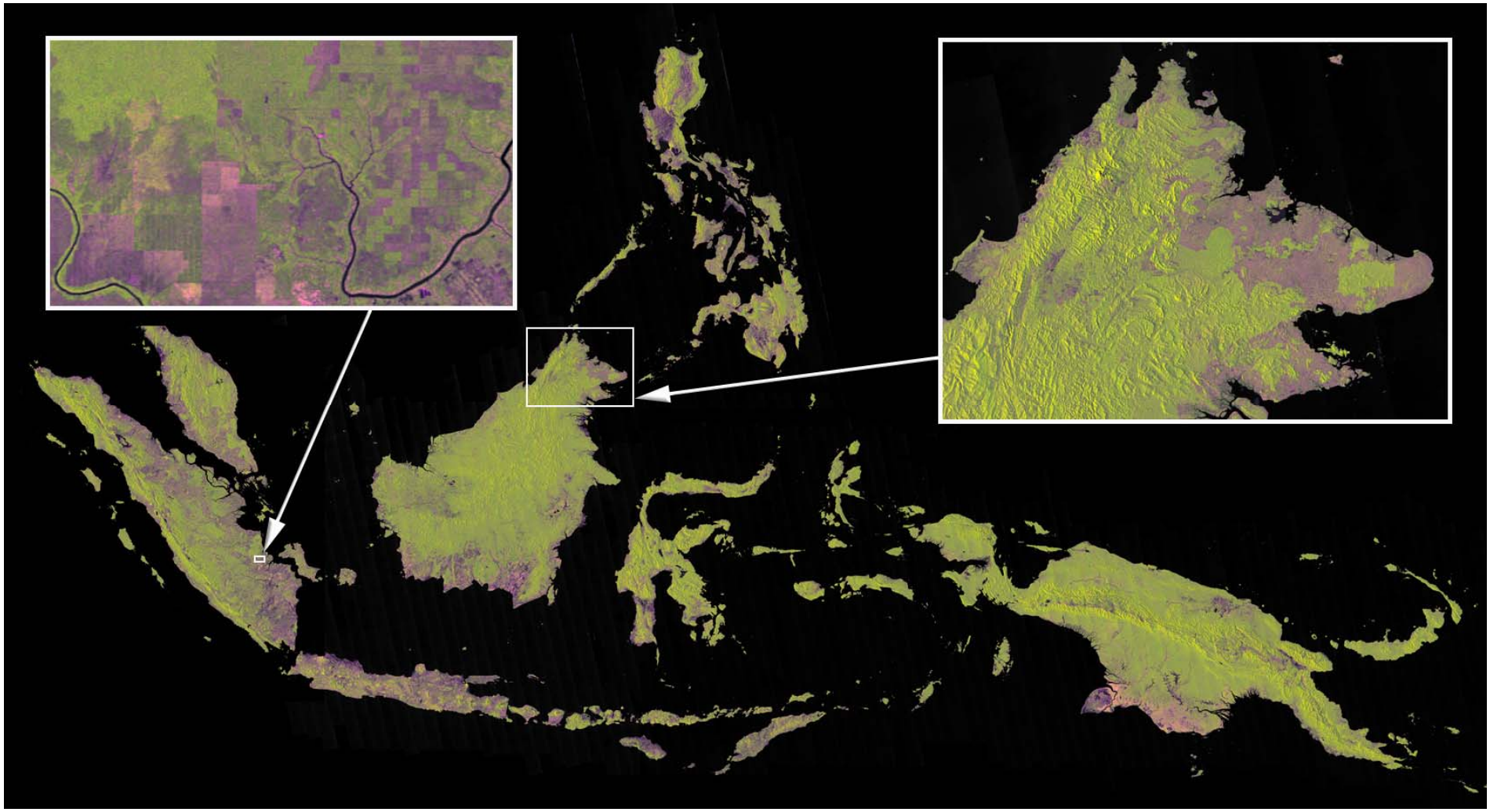


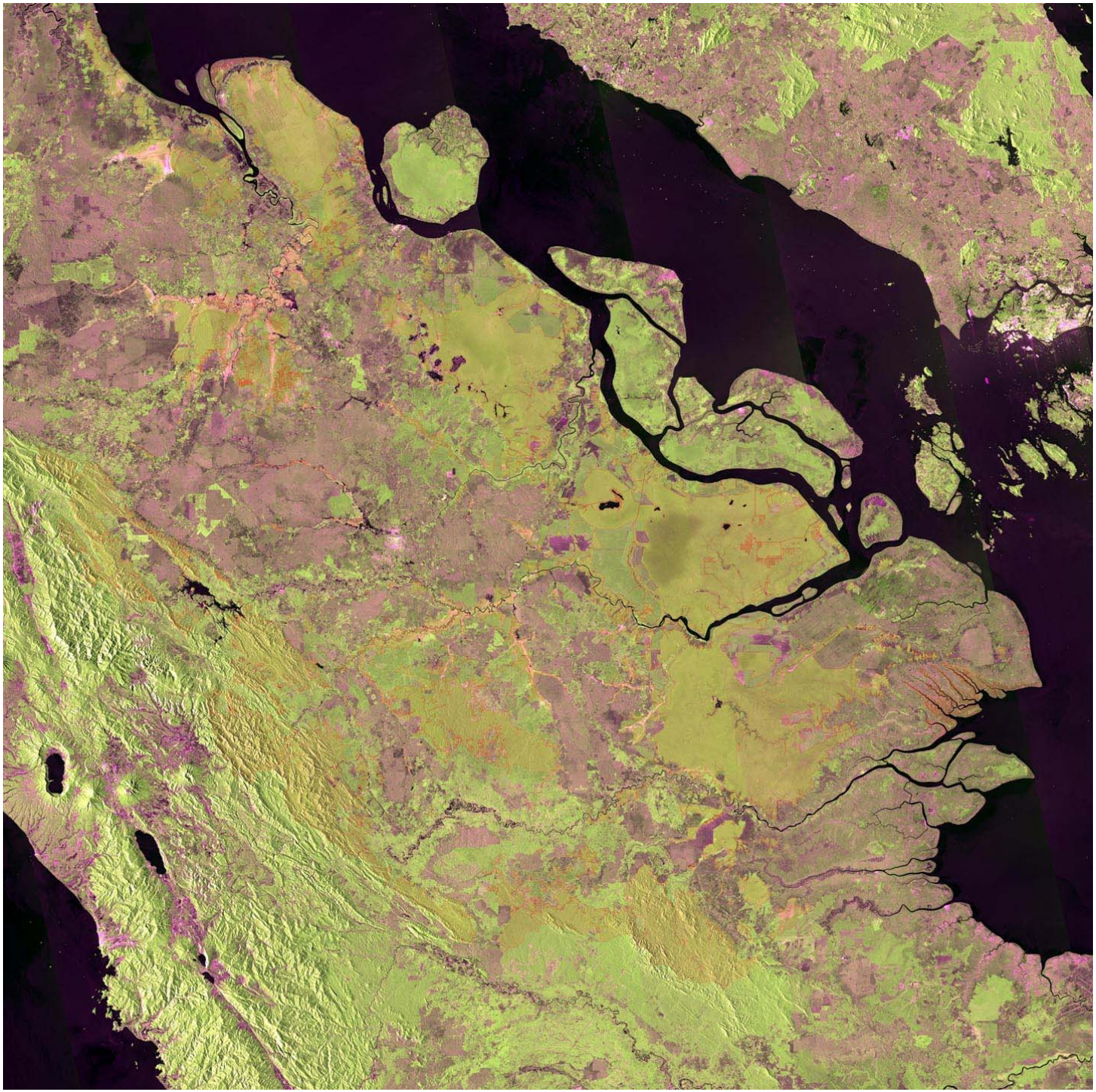
JERS 1993

JERS 1998

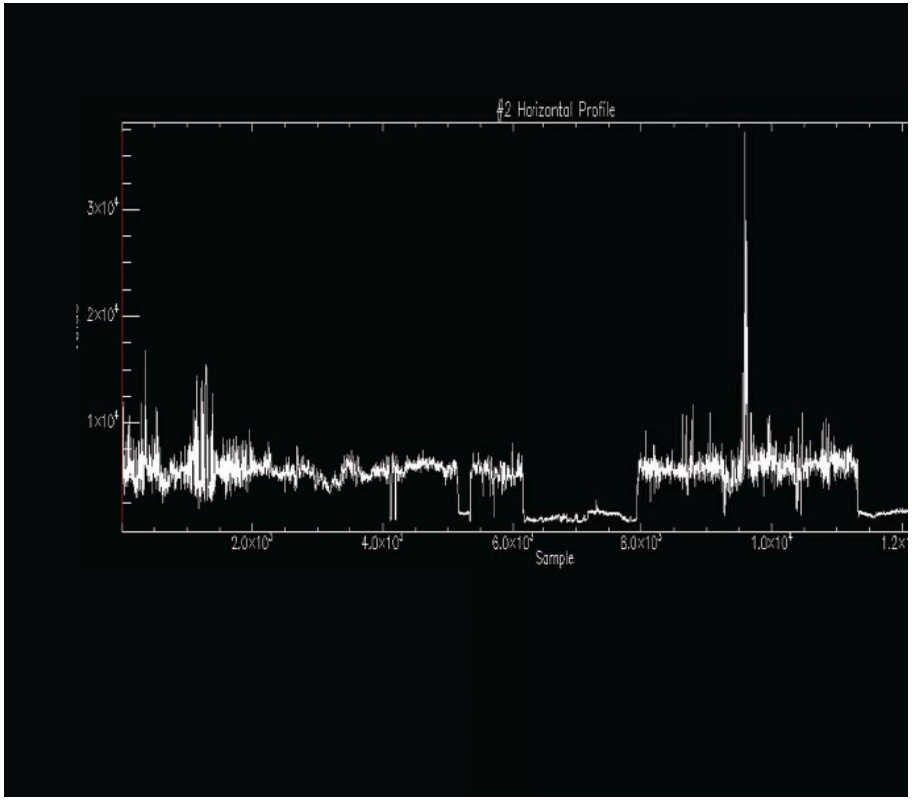
PALSAR 2007

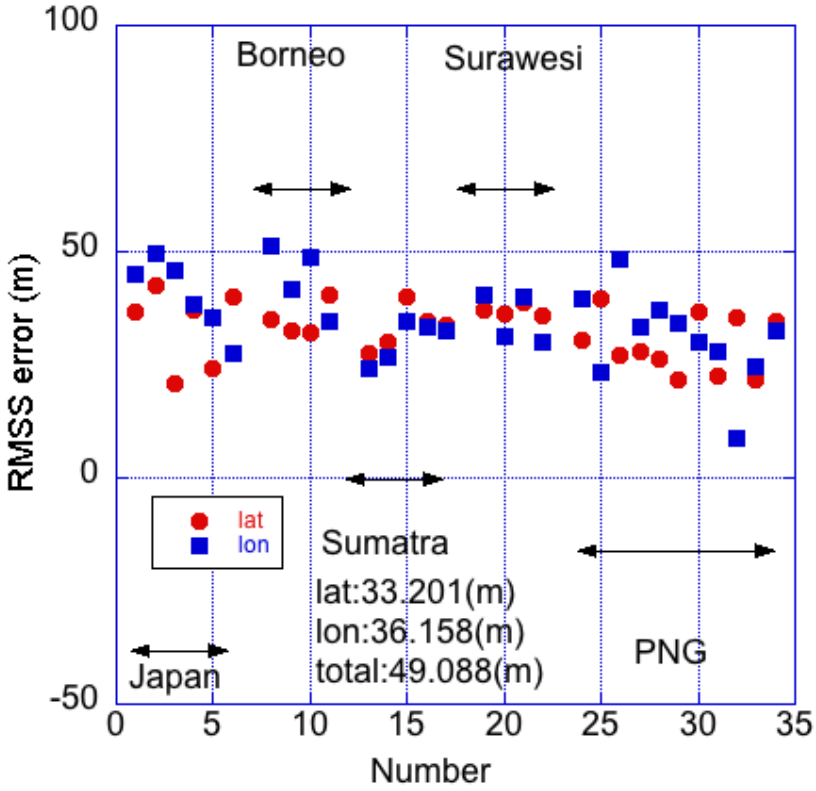
# South East Asia mosaic for South East Asia using FBD



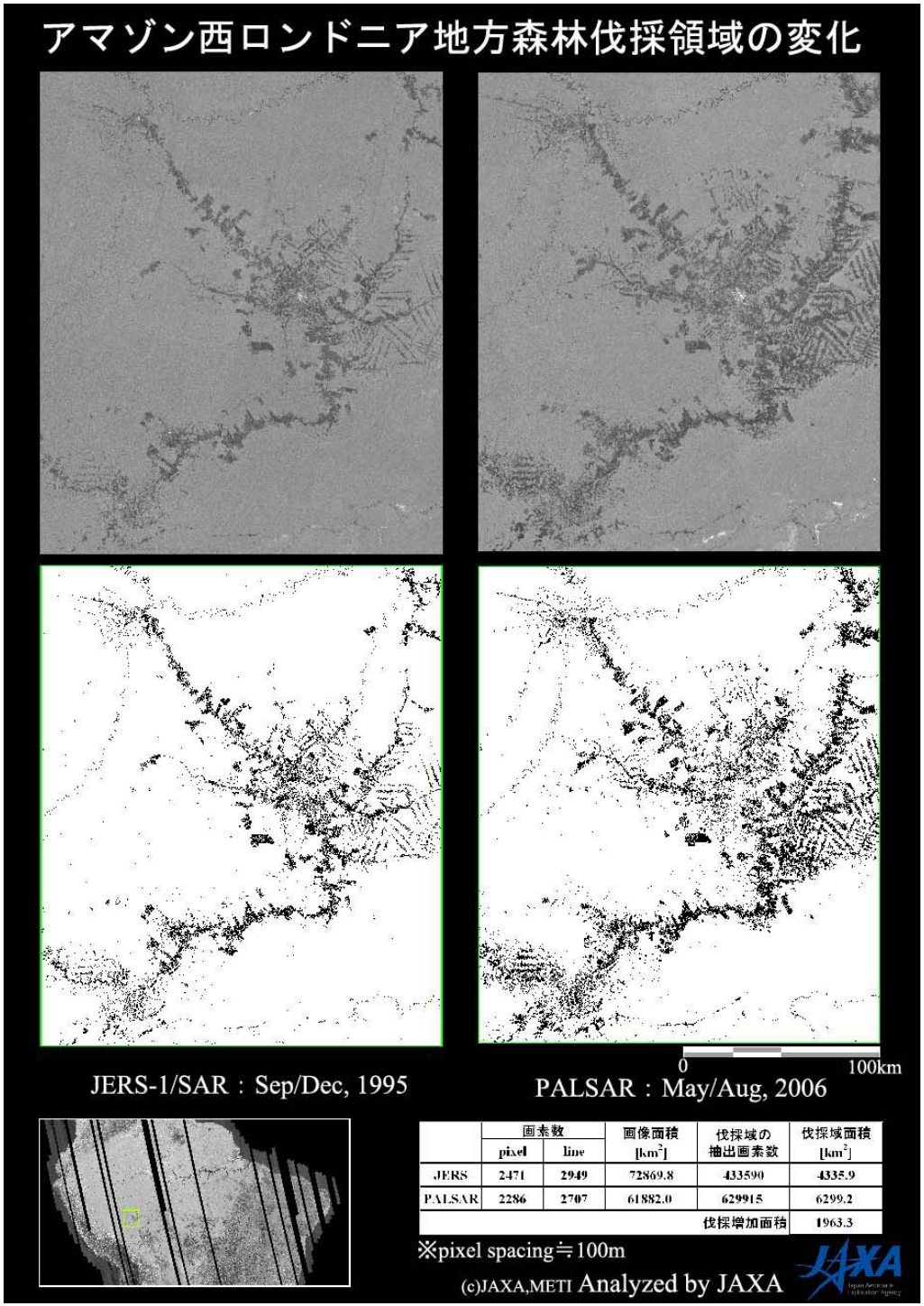


# Evaluation : Geometry and radiometry in Mosaic



STRIP mode imaging




| | 画素数 | | 画像面積 [km$^2$] | 伐採域の抽出画素数 | 伐採域面積 [km$^2$] |
|---|---|---|---|---|---|
| | pixel | line | | | |
| JERS | 2471 | 2949 | 72869.8 | 433590 | 4335.9 |
| PALSAR | 2286 | 2707 | 61882.0 | 629915 | 6299.2 |
| | | | | 伐採増加面積 | 1963.3 |

# Conclusions

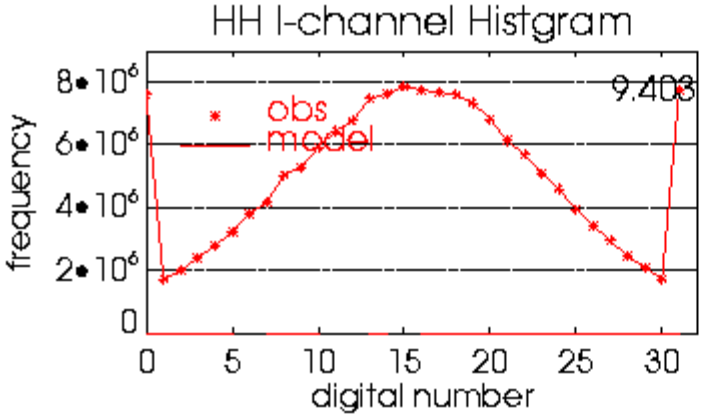
As the basic products for the K&C project, JAXA prepared the mosaic data sets for these regions.

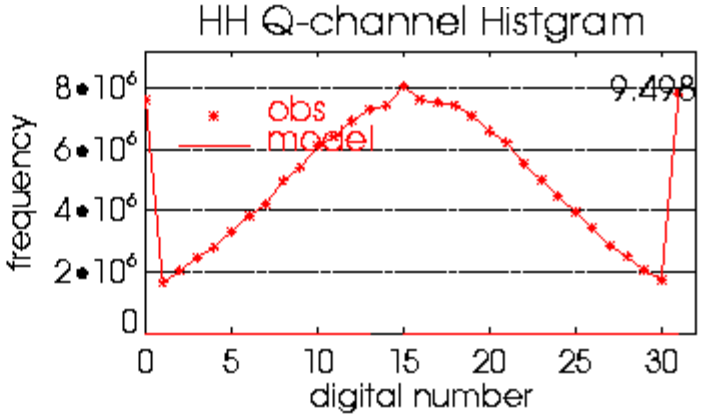
The data products have geometric accuracies of less than 50 meters.

The data are projected onto the equal lat-lon coordinates.

SRTM data are used for generation of the ortho rectification.

./FBS343-0/20060321/RSP413/W0058156001-01-001/ **(Biwa Lake)**



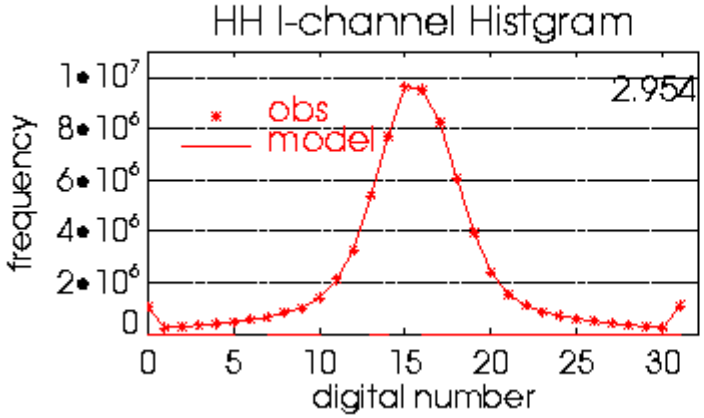

**Attenuator: Auto**

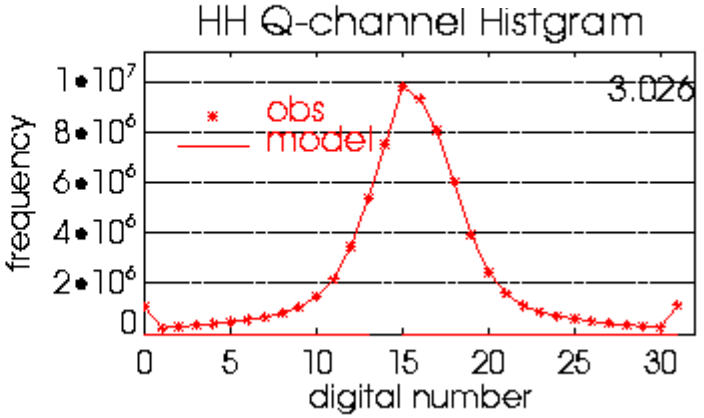
Before：too large Receive gain, saturation

—>After ATT tuning, no more large saturation

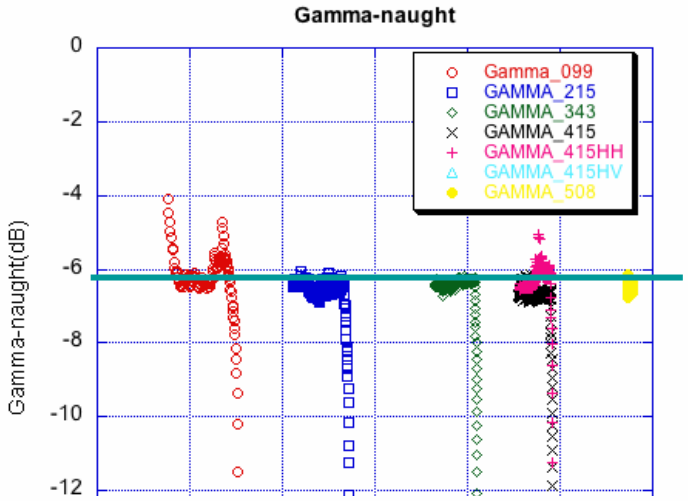
**Attenuator: 25**

./FBS343-0/20060528/RSP417/W012531

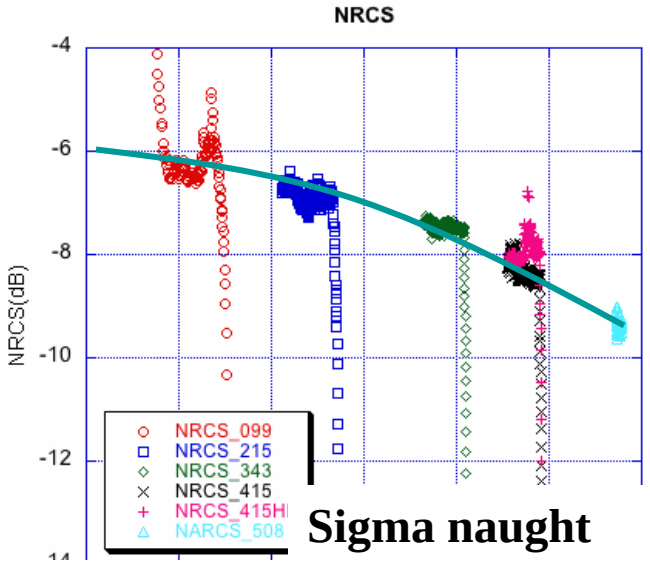


# Evaluation of calibration : Incidence angle dependency of the Amazon sigma-naught, and noise equivalent sigma zero

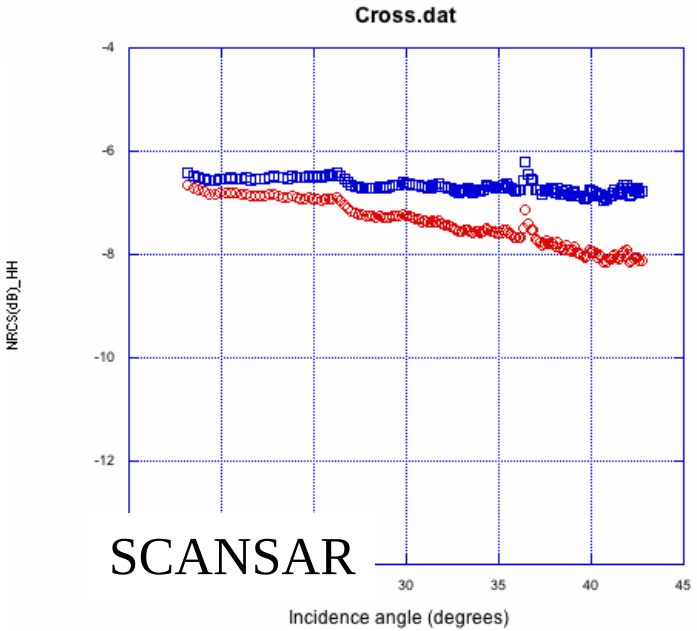



**Gamma naught**

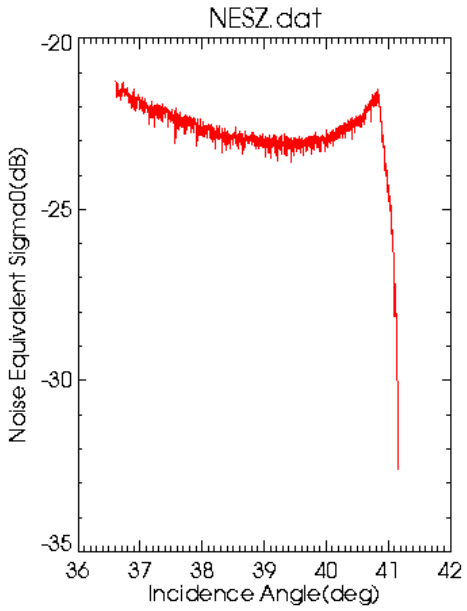



**Sigma naught**

antenna/Greenland/FBS343H/RSP041/20060715

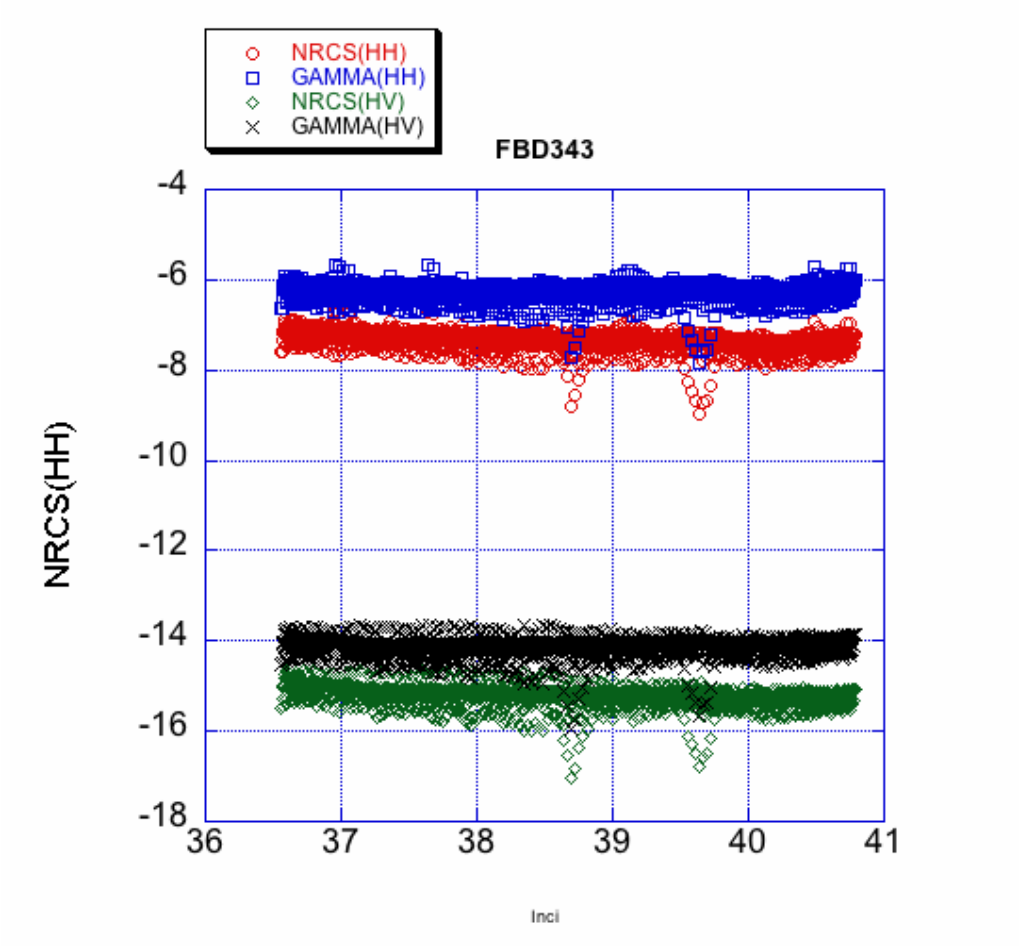



SCANSAR




-23 dB

# GAMMA-naught vs. incidence for HH and HV (NEW)




Flat in incidence angle