SAR cross-calibration using natural targets

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Outline

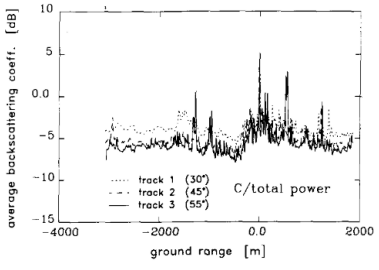
1. SAR Cross-calibration overview
2. Cross-calibration procedure
3. Cross-calibration results
4. Future plan

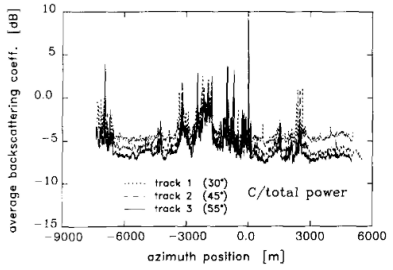
SAR cross-calibration overview

E-SAR/DC-8 SAR calibration campaign

- The first trial for the cross-calibration/validation between two SAR sensors.
- The calibration parameters derived from different tracks were used to describe this stability. Criteria for cross-calibration performance are the agreement of σ_0 values and the consistency of radar cross-sections of equally sized corner reflectors.

E-SAR

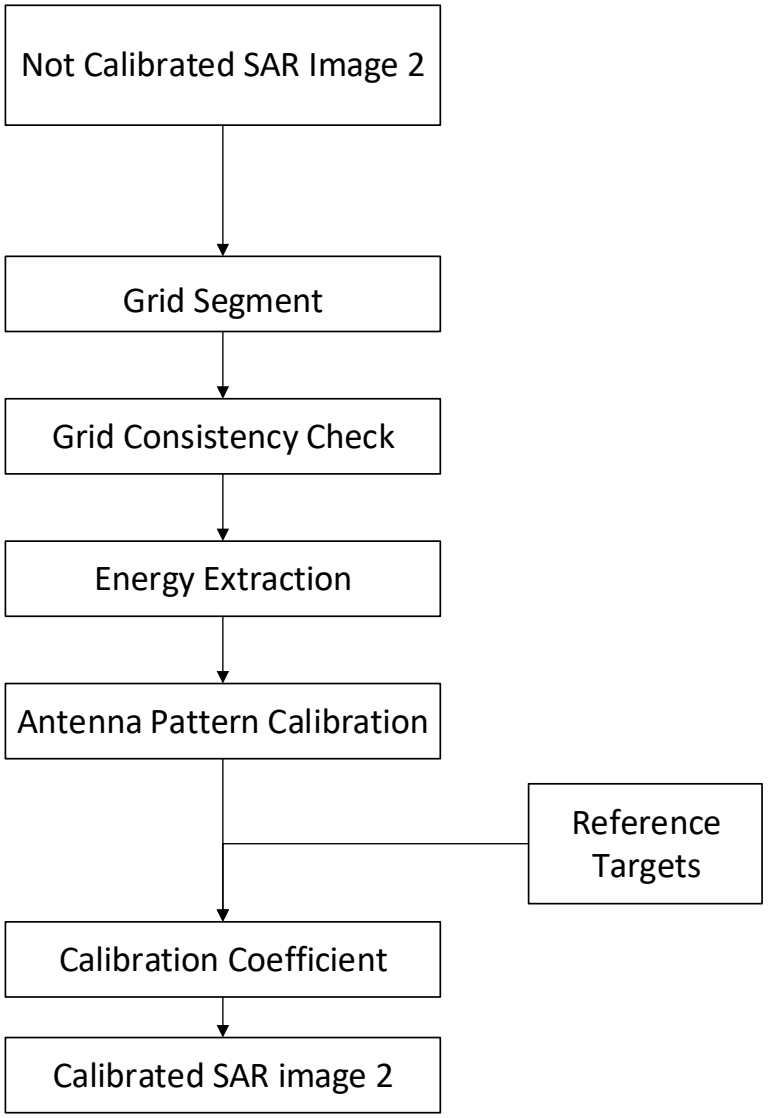




Cross-calibration procedure

Feature

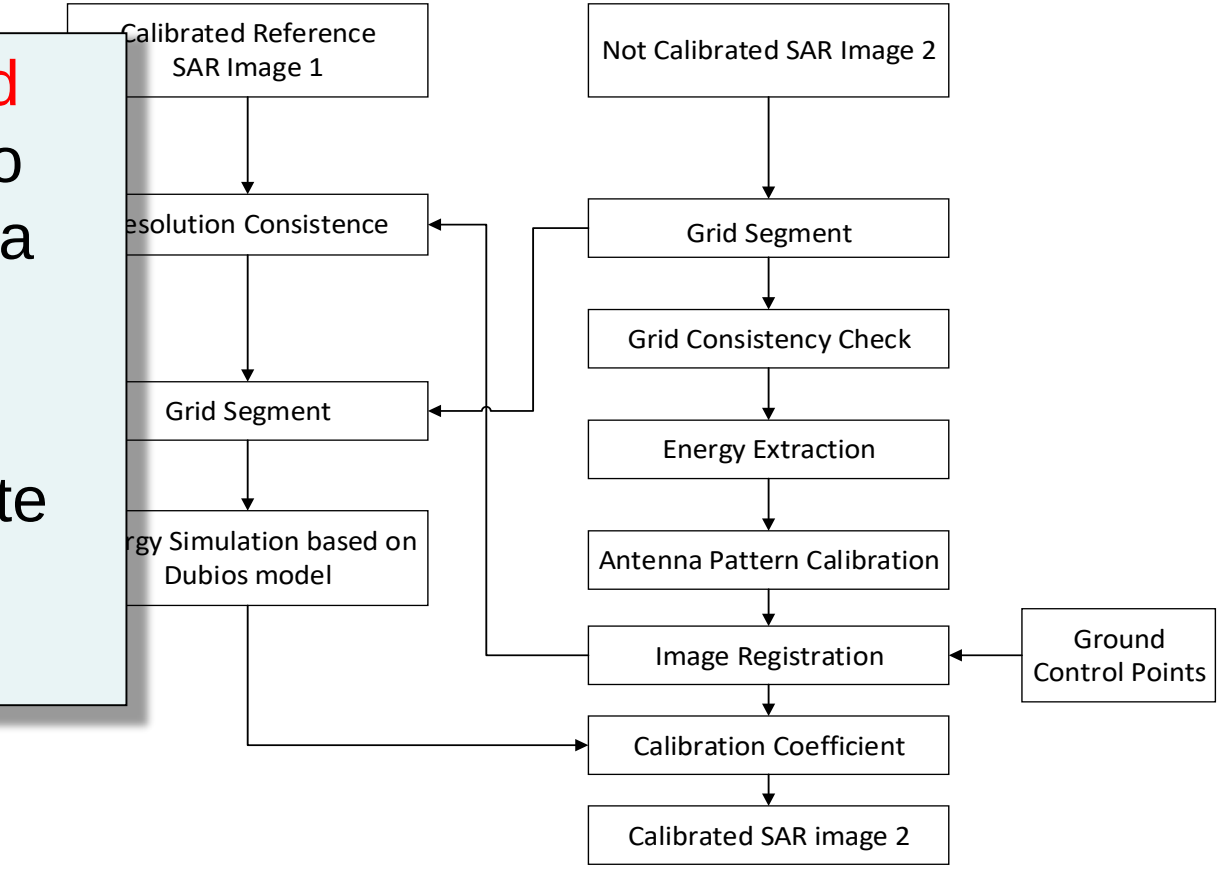
- Using distributed natural targets to calibrate antenna pattern
- Using reference targets like dihedral/trihedral/APRC corner reflector to calibrate the total system gain



Cross calibration procedure

Feature

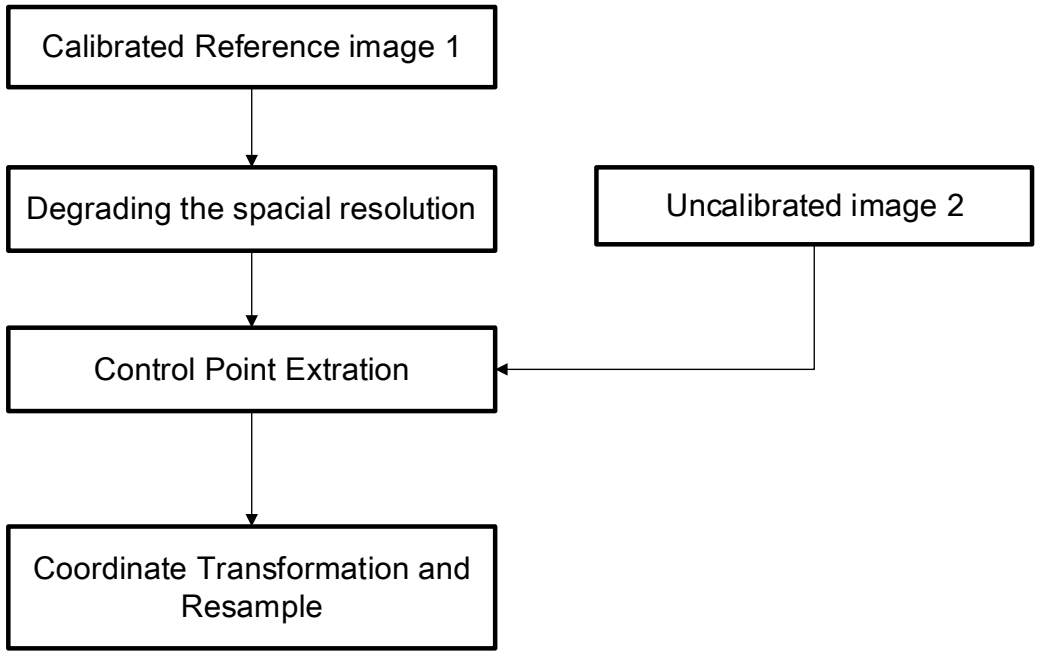
- Using distributed natural targets to calibrate antenna pattern
- Using reference image to calibrate the total system gain



Cross calibration procedure

Image Registration

- Degrading the reference image spacial resolution to the same extent to the uncalibrated image 2
- Extract control point (reflectors)
- Coordinate transformation and Resample



Cross calibration procedure

Energy Simulation

- Oh model

$$p = \frac{\sigma^0_{hh}}{\sigma^0_{vv}} = \left\{1 - \left(\frac{2\theta}{\pi}\right)^{\frac{1}{3R(0)}} \exp(-ks)\right\}^2 \qquad q = \frac{\sigma^0_{hv}}{\sigma^0_{vv}} = 0.23\sqrt{R(0)}\left[-\exp(-ks)\right]$$

- Dubois model

$$\sigma^0_{vv} = 10^{-2.35}\left(\frac{\cos^3\theta}{\sin^3\theta}\right)10^{0.046\varepsilon\tan\theta}\left(ks\sin\theta\right)^{1.1}\lambda^{0.7} \qquad \sigma^0_{hh} = 10^{-2.75}\left(\frac{\cos^{1.5}\theta}{\sin^{1.5}\theta}\right)10^{0.028\varepsilon\tan\theta}\left(ks\sin\theta\right)^{1.4}\lambda^{0.7}$$

- Shi model

$$10\log_{10}\left(\frac{|\alpha_{pp}|^2}{\sigma^0_{pp}}\right) = \alpha_{pp}(\theta) + b_{pp}(\theta)10\log_{10}\left(\frac{1}{s_r}\right) \qquad 10\log_{10}\left(\frac{|\alpha_{vv}|^2 + |\alpha_{hh}|^2}{\sigma^0_{vv} + \sigma^0_{hh}}\right) = \alpha_{vh}(\theta) + b_{vh}(\theta)10\log_{10}\left(\frac{|\alpha_{vv}||\alpha_{hh}|}{\sqrt{\sigma^0_{vv}\sigma^0_{hh}}}\right)$$

GaoFen-3 & Sentinel-1A

Image information

GaoFen-3 Calibrated Image
Incidence angle:47° ~ 48 °
Resolution：8m
waveband：C band

Sentinel-1A Calibrated Image
Incidence angle: 30 ° ~36 °
Resolution：20ml
waveband ： C band

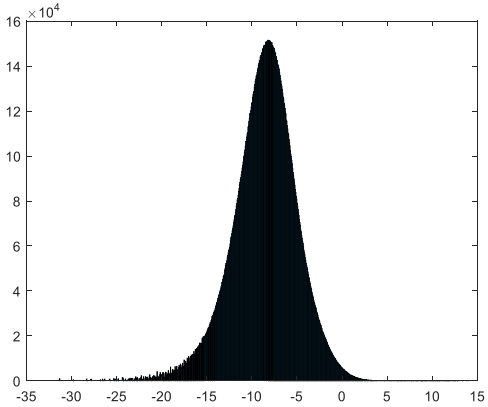
GaoFen-3 data

Sentinel-1A data

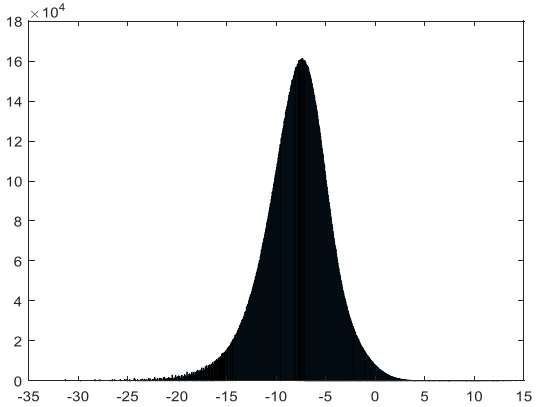
GaoFen-3 & Sentinel-1A

Image information

GaoFen-3 Calibrated Image
Histogram
Incidence angle: 47 ° ~48 °
Resolution：8m



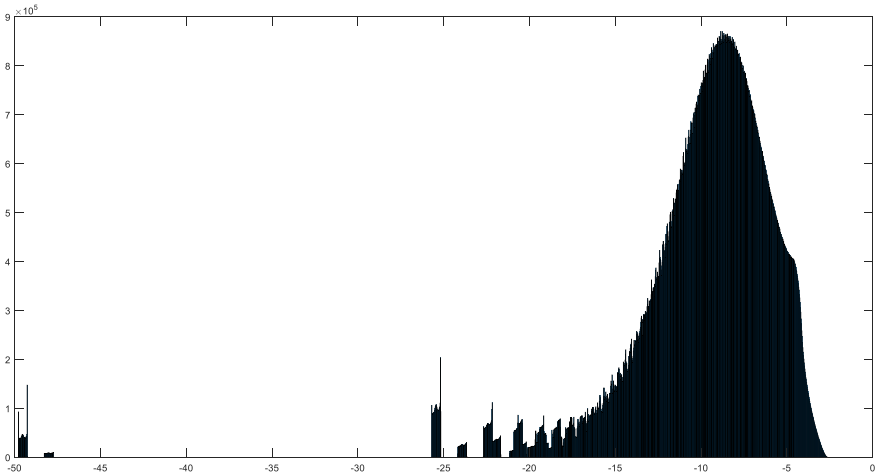
HH



VV

GaoFen-3 data

Sentinel-1A Calibrated Image
Incidence angle: 30 ° ~36 °
Resolution：20m

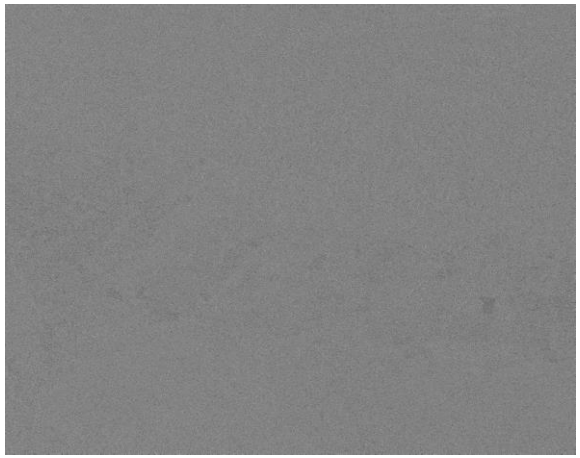


VV

Sentinel-1A data

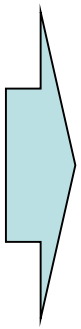
Energy Simulation

Using Dubois model to simulate the convolution power



permittivity

Mean square root height

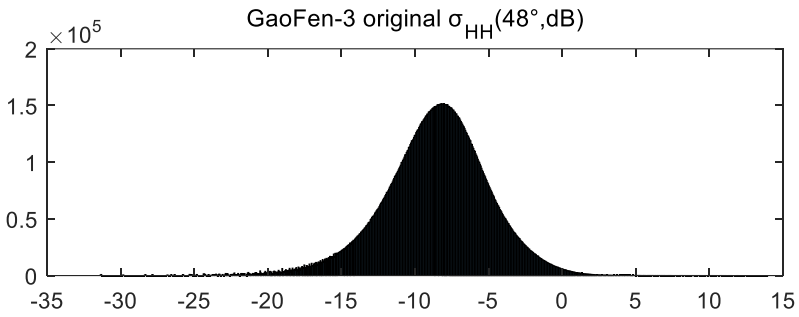


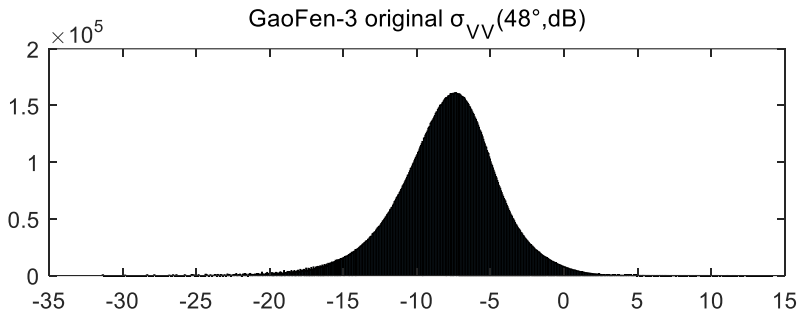
HH simulate energy

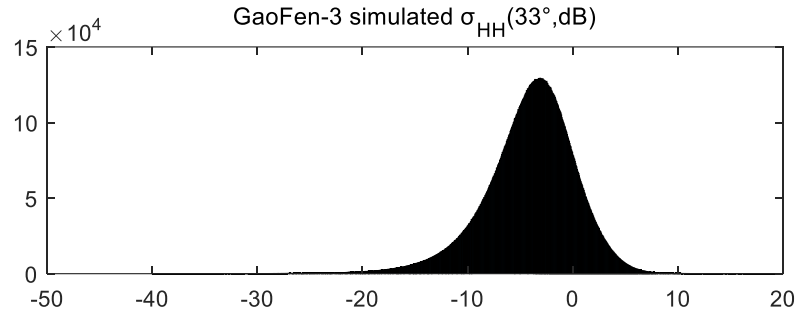
VV simulate energy

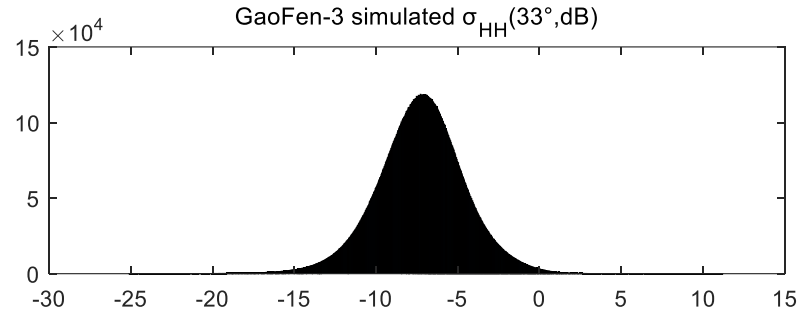
Energy Simulation

Contrast between calibration data and simulation data









GaoFen-3 & Sentinel-1A

GaoFen-3 image after Image Registration to Sentinel SAR sensors

GaoFen-3 data

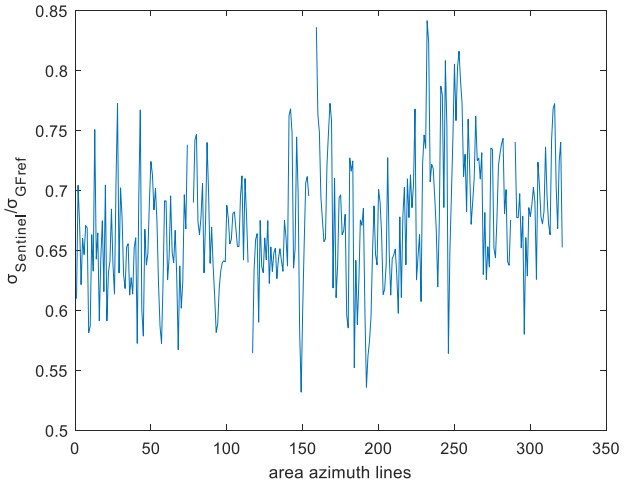
Sentinel-1A data

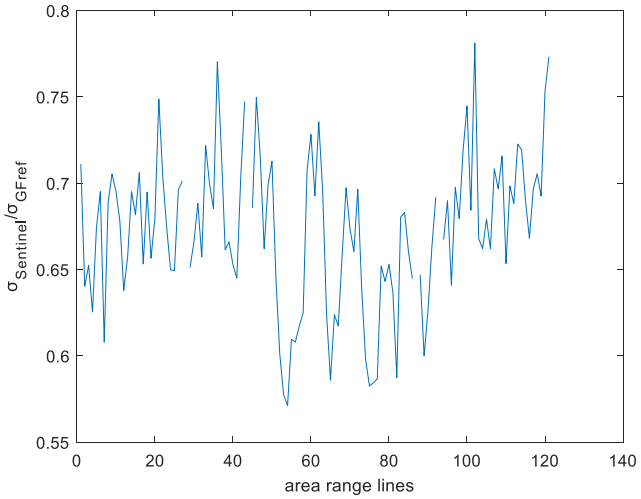
Using reference image to calibrate

GaoFen-3 calibrated image after Image Registration & Energy simulation. Comparing with Sentinel-1A SAR sensors

Using reference image to calibrate

Compare the bare soil region simulation RCS and origin RCS





Future plan

- Image registration method
- Energy simulation accuracy (land surface parameters retrieval method)


Thank you !