

Abstract

Radiometric analysis involves evaluating SAR data using homogeneous distributed targets having stable and uniform backscatter properties. EOS-04 is ISRO's State-of-the-Art Earth Observation C-band SAR mission launched in 2022 having Stripmap (FRS-1/2), ScanSAR (MRS/CRS) and Sliding Spotlight (HRS) capabilities operating in single, dual, Hybrid or Full polarimetry to cater to various RS application requirements. Calibration and Validation of EOS-04 SAR has been performed using Amazon and Cameroon Rain Forests which were announced by SAR subgroup of CEOS Working Group on Calibration and Validation (WGCV) as standard homogeneous distributed targets. The evaluation has been performed by assessing radiometric accuracy and elevation antenna pattern compensation by deriving gamma0 pattern by masking water bodies in the Rain forests. Comprehensive analysis has been carried out over Amazon and Cameroon Rain Forests for Right/Left look directions, Ascending /Descending nodes, operational imaging modes and polarization configurations of EOS-04. The derived gamma0 patterns and its mean values are stable and deviation w.r.t standard reference value of co and cross polarizations are within 1 dB showing consistent absolute and relative radiometric accuracy of EOS-04 data products.

EOS-04: ISRO's indigenous C-band SAR (a follow-on of RISAT-1) – Launched in February 2022

Capabilities of EOS-04 SAR Mission

- Frequency: 5.4 GHz ± 37.5MHz
- Satellite Altitude: 524.87 Km
- Imaging Modes: Stripmap , ScanSAR and Sliding-Spotlight
- Polarizations: Single, Dual, Compact (CP) & Full (FP)
- Swath Coverage: 15 Km to 223 Km
- Spatial Resolutions: 1m to 50m
- Incidence angle: 12.4 – 55.5 deg

Product Specifications	Value
Geo-location Accuracy(RMSE)	<50 m
Radiometric Resolution (SLC)	3.1 dB
PSLR	-17 dB
Relative Radiometric Accuracy	1 dB
Absolute Radiometric Accuracy	± 1 dB

State-of-the-Art :

- ✓ Stripmap and ScanSAR mode of Operation of EOS-04 offering Hybrid and Full polarimetric measurements to the user community.
- ✓ EOS-04 data has been calibrated and validated using corner reflectors and data acquired over homogenously distributed targets like Amazon Rain Forest.

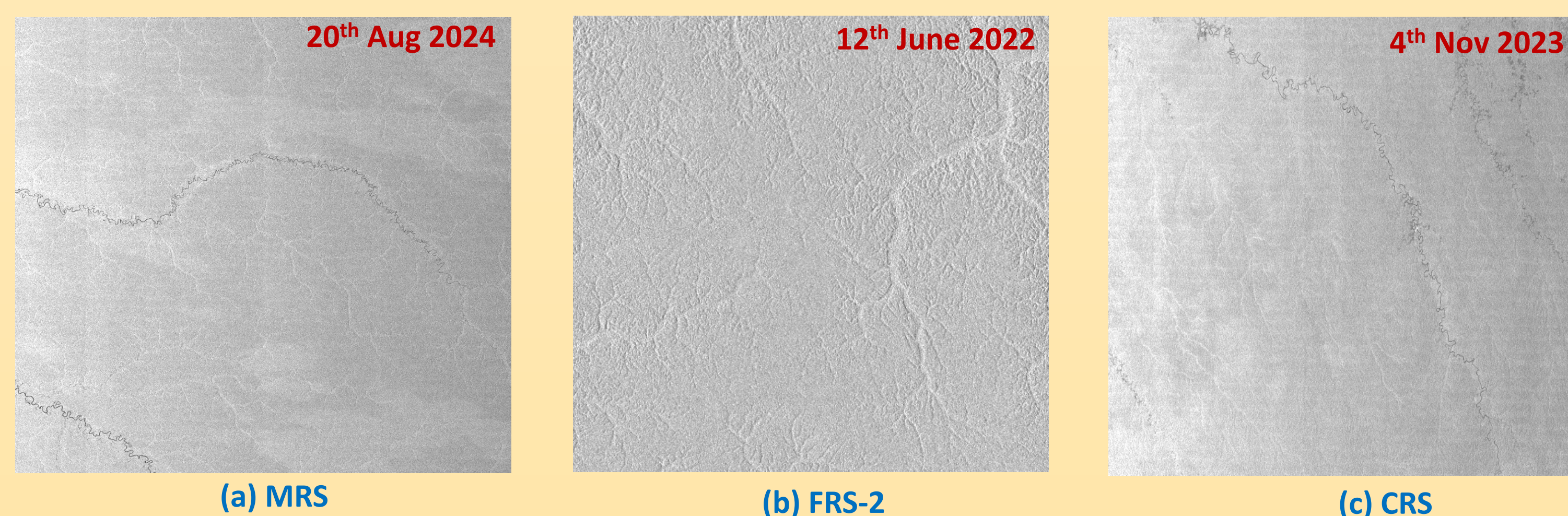
As per India's Space Data policy 2023, satellite data of 5m and coarser is FREE and OPEN for public and data finer than 5m is priced and to be ordered as per existing procedure at ISRO's Bhoonidhi EO Data Dissemination web portal <https://bhoonidhi.nrsr.gov.in/>



Methodology

SAR calibration and validation is essential for ensuring the reliability and accuracy of the SAR sensor and data products. EOS-04 Level-1 Ground Range data products acquired over Amazon and Cameroon rain forest are considered for studying the EOS-04 radiometric accuracy and gamma0 variation across the swath. Gamma naught values are derived for each DN value in the image with its calibration constant and all the pixels are averaged to a single value for each range gate. Water Bodies in the rain forest region are masked to get the gamma0 values corresponding to only Forest canopy. All the average values are plotted against pixel numbers to arrive at the gamma naught pattern. Absolute radiometric accuracy has been evaluated by comparing mean gamma0 value with the reference value of gamma0 of Amazon rain forest. (Standardized by international SAR sensors).

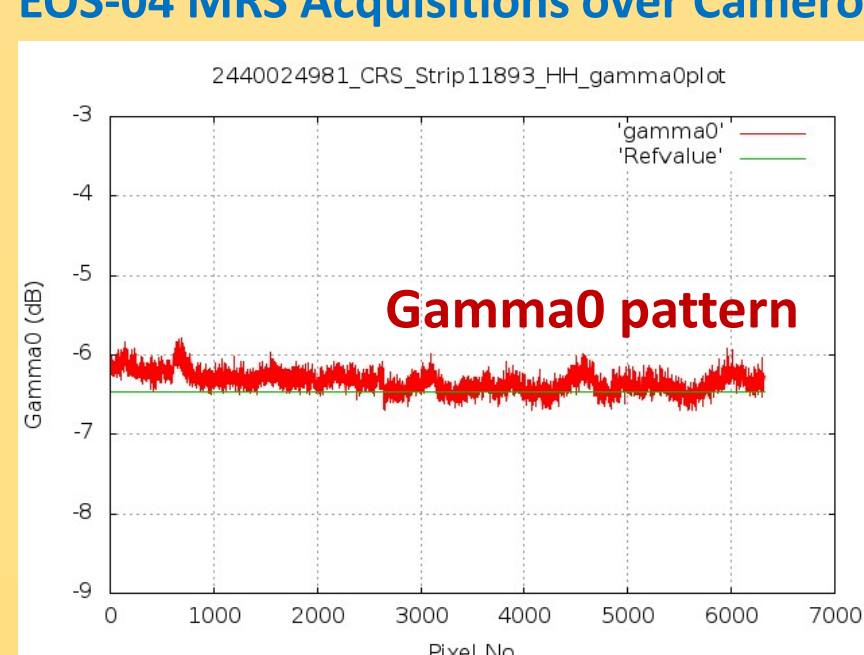
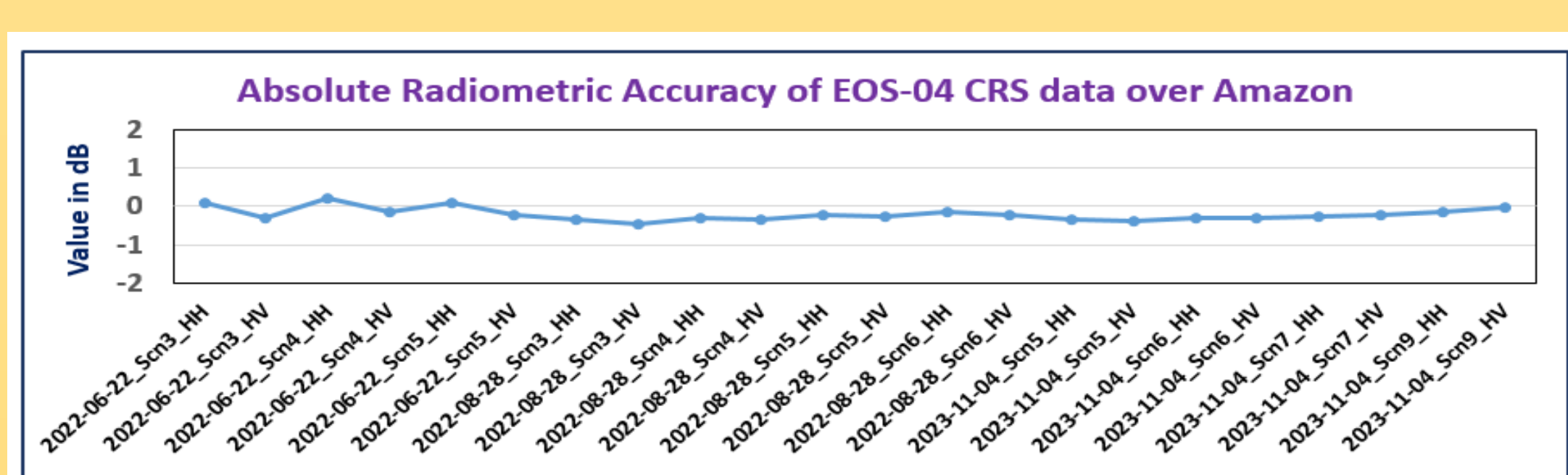
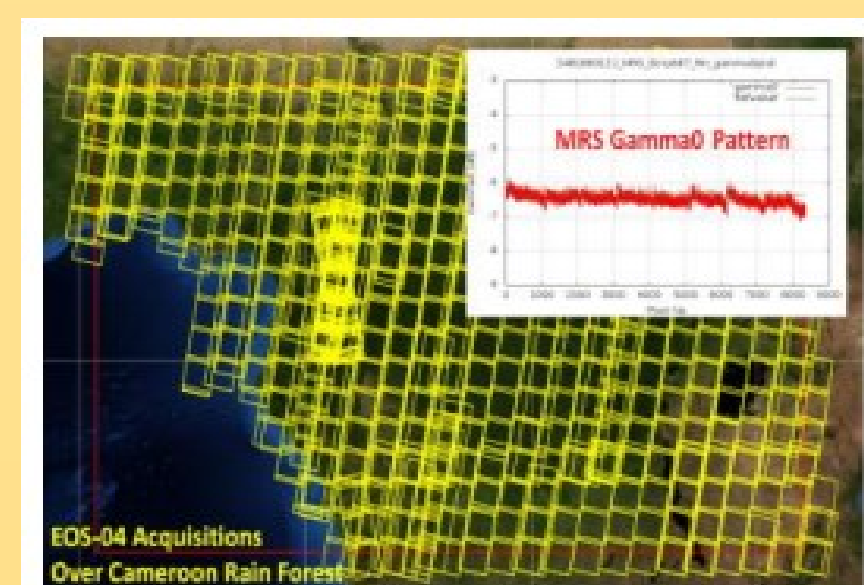
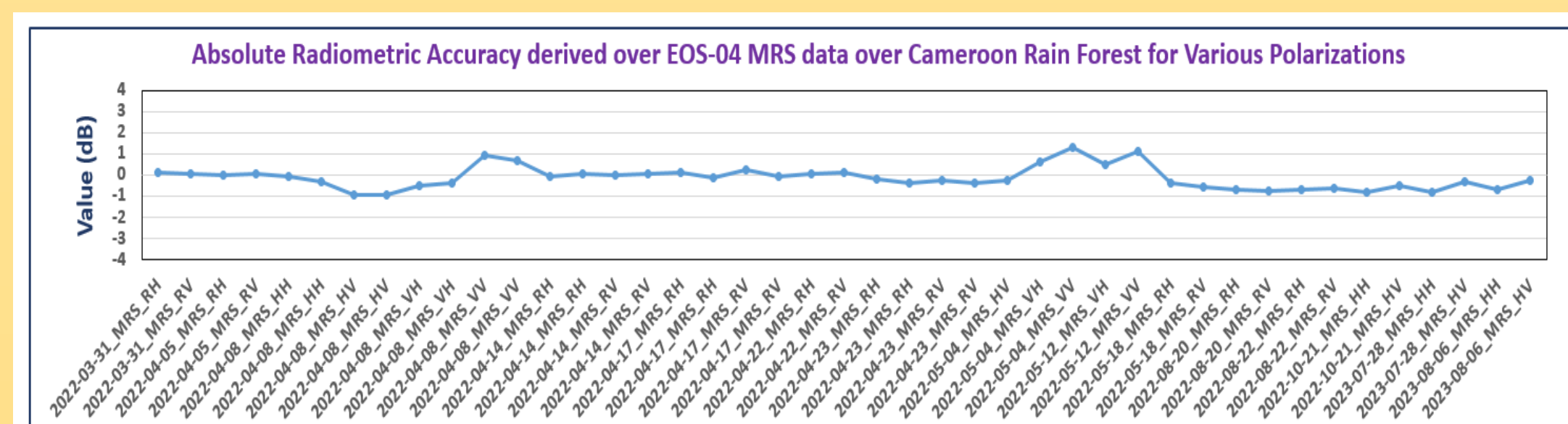
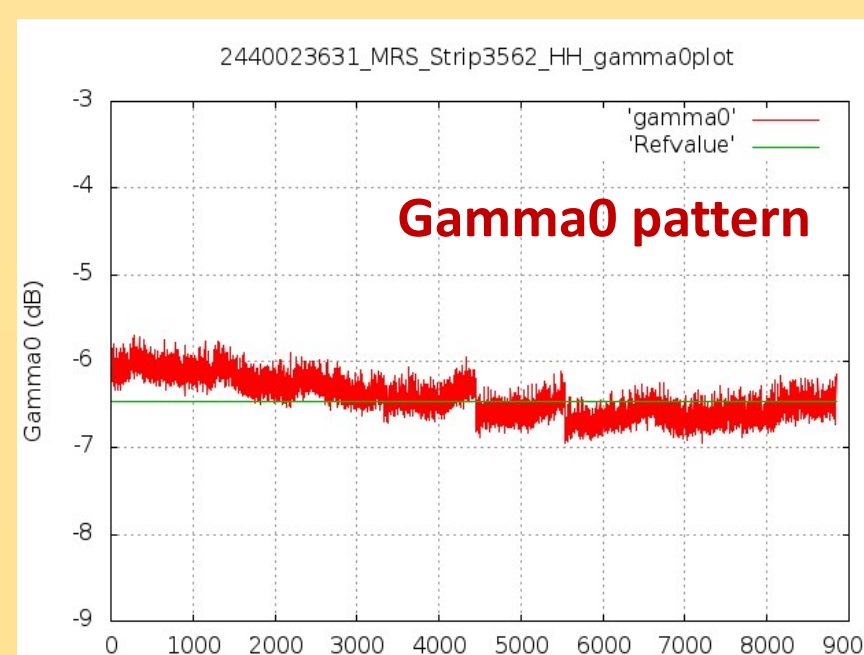
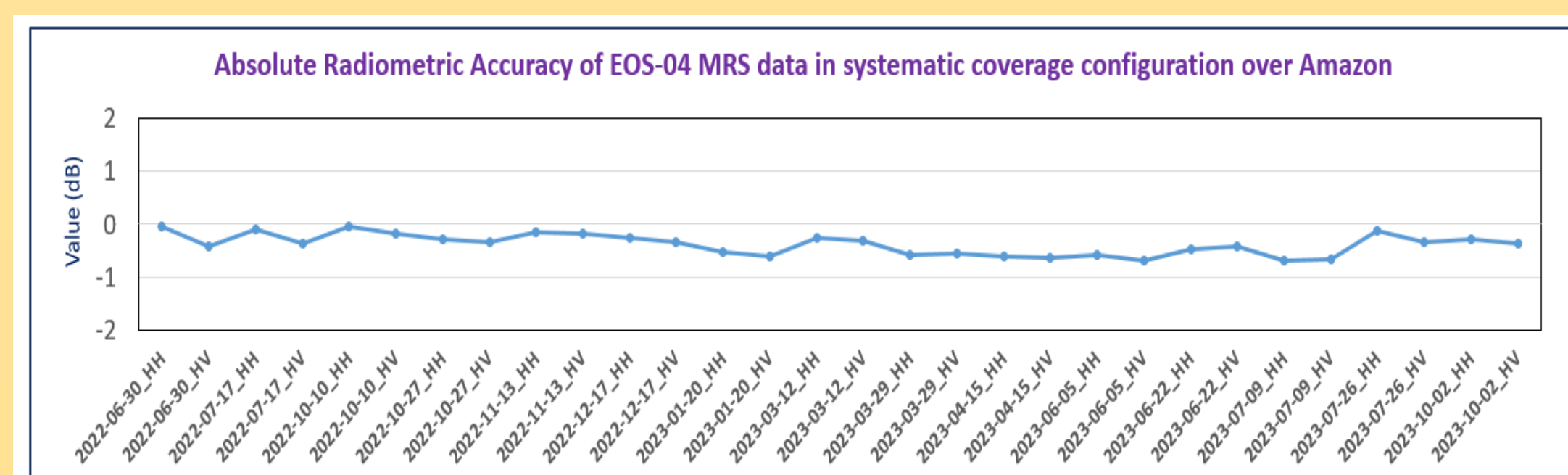
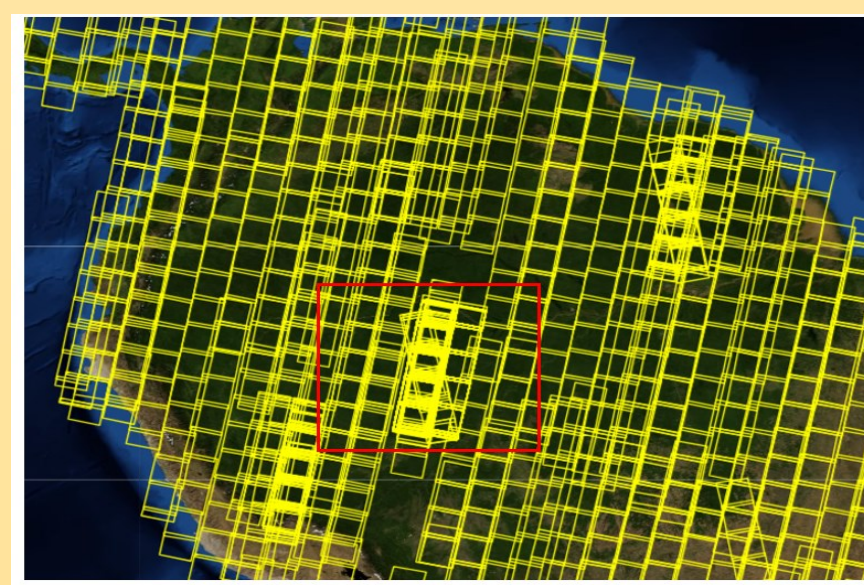
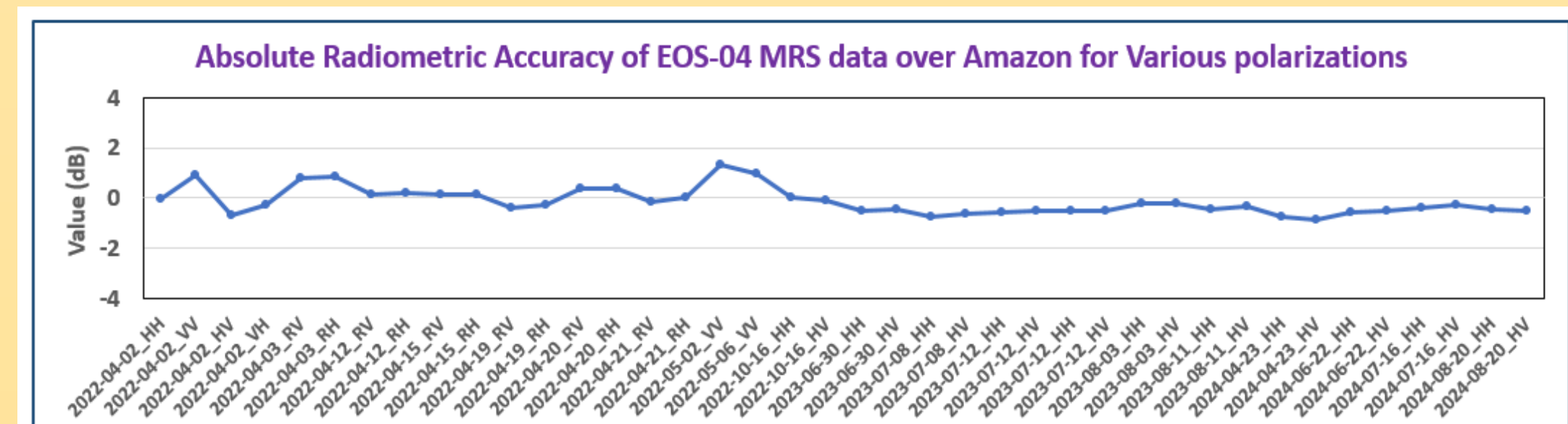
Results



EOS-04 Data acquired over Amazon rain forest

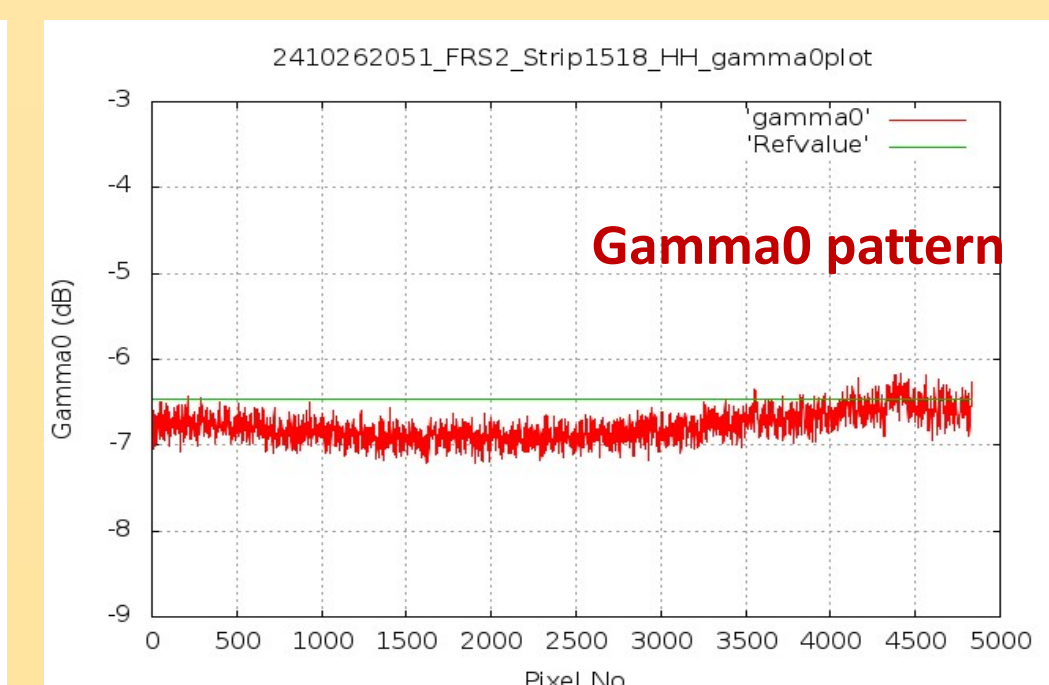
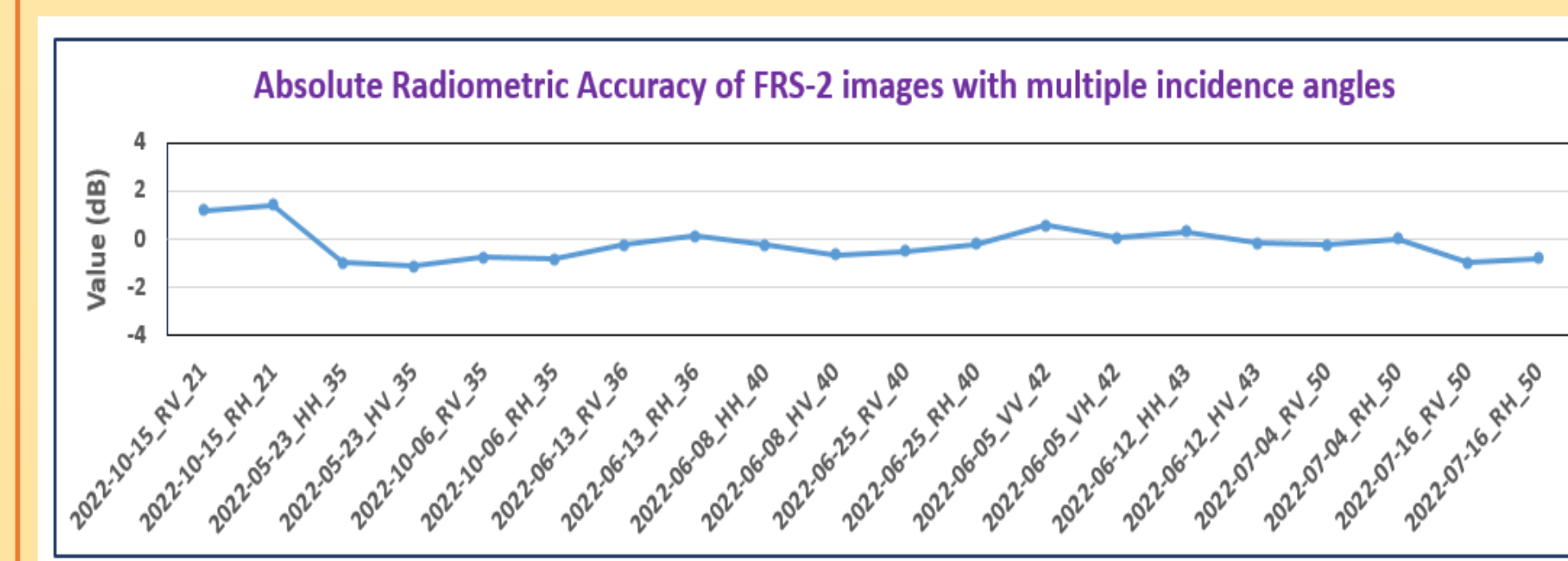
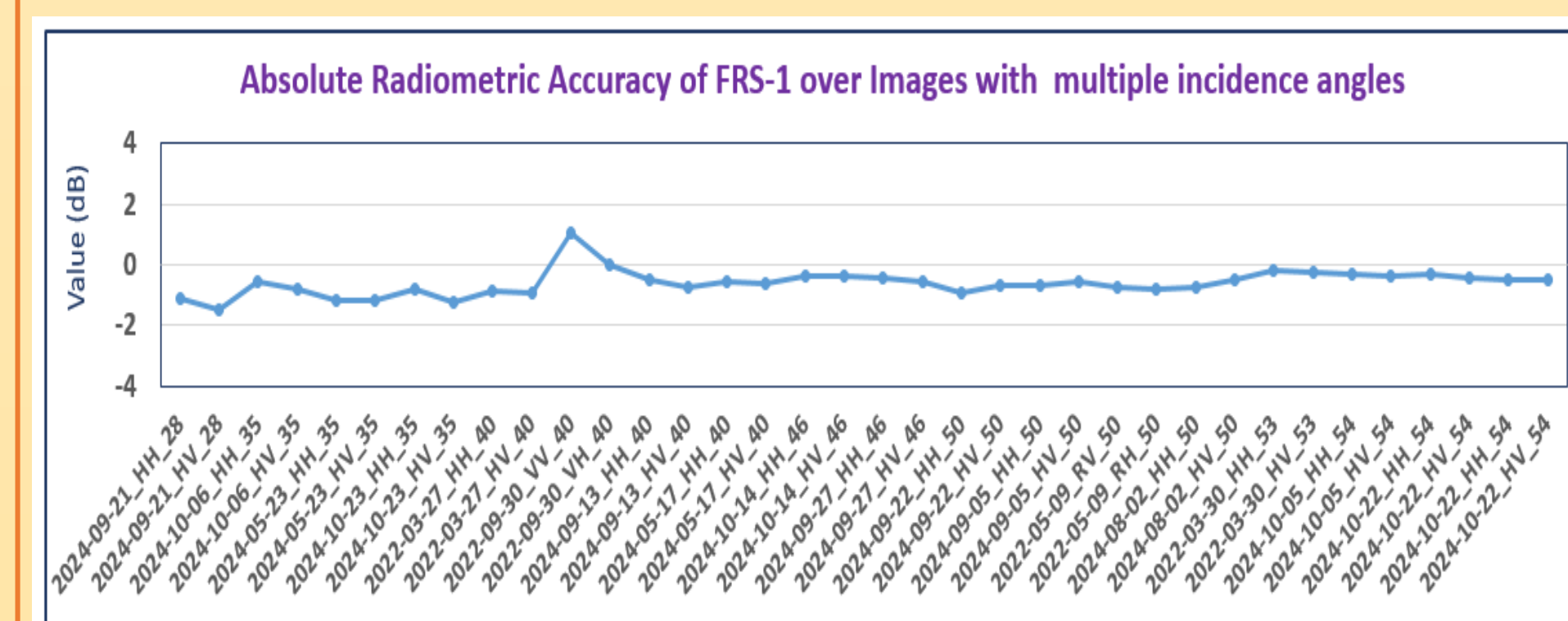
Radiometric Analysis over ScanSAR (MRS,CRS) Data

Derived Gamma0 patterns and estimated radiometric accuracy over 100 EOS-04 MRS acquisitions of Amazon and Cameroon Rain Forest with multiple incidence angles and polarizations in Right/Left Look directions. From the results, it was observed that absolute and relative radiometric accuracy is within 1dB for ScanSAR data products.



Radiometric Analysis over Stripmap (FRS-1, FRS-2) Data

Radiometric analysis has been performed over EOS-04 FRS-1, FRS-2 datasets with multiple incidence angles acquired over 3 AOIs of Amazon Rain Forest . From the results, it was observed that for most of the acquisitions the absolute radiometric accuracy is within 1dB except for few acquisitions with lower incidence angles.



Summary

- ❖ EOS-04 Data acquired over Rain Forest Regions in stripmap and ScanSAR imaging modes over past 2 years with various incidence angle and polarization combinations are considered to estimate the absolute radiometric accuracy and gamma0 variation across swath.
- ❖ Similar results observed in Amazon and Cameroon Rain Forest Regions.
- ❖ From the comprehensive analysis, it was observed that the derived absolute & relative radiometric accuracy values are within the specifications of EOS-04.

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