

G42D-0260 - Evaluating SAR Radiometric Terrain Correction Solutions: Optimal products for applied users

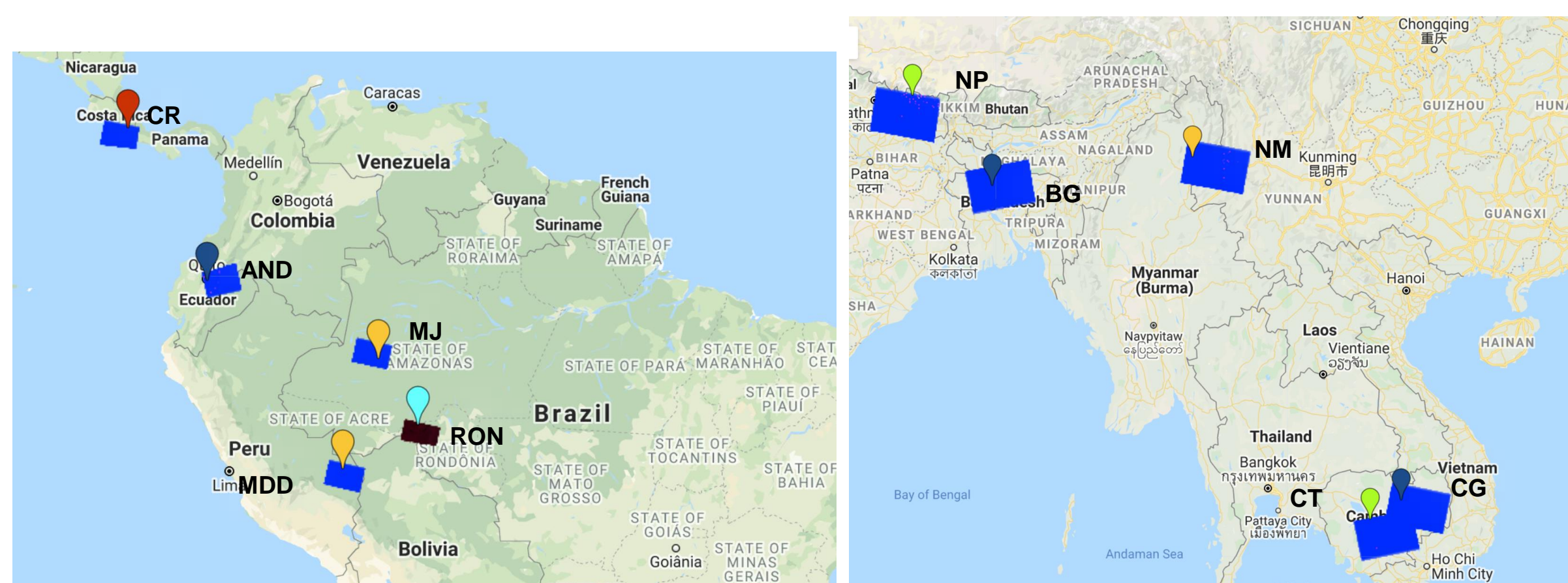
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1. Introduction

Operational applications of Synthetic Aperture Radar (SAR) are under development around the world, driven by the regularly-acquired, free-and-open source C-band SAR observations provided by ESA's Sentinel-1 sensor constellation since 2014. Groups like SERVIR, a joint NASA and USAID initiative, are at the forefront of remote sensing applications for societal benefit. A takeaway from SERVIR's experience is the need for appropriately geocoded and fully calibrated SAR data that is ready to use for a range of ecosystems-related applications. Radiometric Terrain Corrected (RTC) data are key entry-level products for multiple applications that range from ecosystems to hazards. This work fills a gap in current research by evaluating several RTCs produced by open-source software solutions (SNAP-7 and ISCE-2), the gold standard commercial software (GAMMA), a Google Earth Engine (GEE) based workflow, and the uncorrected GRD products currently available in GEE. RTCs were analyzed for geolocation quality, absolute radiometric calibration, and fidelity of the radiometric terrain flattening over ten sites representing varied terrains. In addition, a time series analysis was conducted over two locations. Overall, no significant differences for radiometric calibration were found across RTC products. However, all RTCs performed better than uncorrected GRD products. The main differences between products were found in geolocation quality. These results not only demonstrate the need for the uptake and distribution of RTC products for ecosystems applications, but demonstrate the ability to do so with open source methods, adding value to developing affordable operational applications.

2. Area of Interest



3. Datasets

Parameter	Product	Source	Resolution
C-Band SAR HV and VV backscatter	Sentinel 1	Alaska Satellite Facility DAAC	6 days, 25 m
DEM	ASF correction of SRTM	Alaska Satellite Facility DAAC	2000 (once), 30 m
Land Cover	Regional Land Cover Monitoring System (RLCMS)	SERVIR-Mekong	Annual, 30 m
	RLCMS	SERVIR-Hindu Kush Himalaya	Annual, 30 m
	MapBiomass	Observatoria do Clima and Greenhouse Gas Emissions Estimation System (SEEG)	
Optical	WV3 orthorectified	MAXAR	

4. Metrics

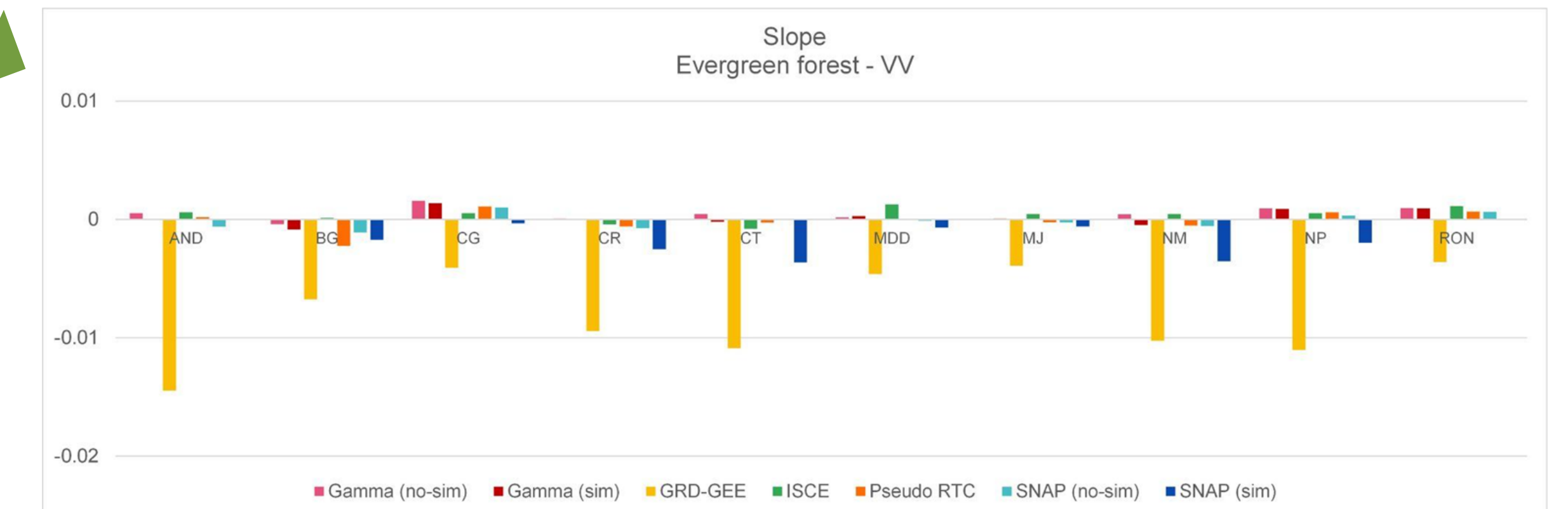
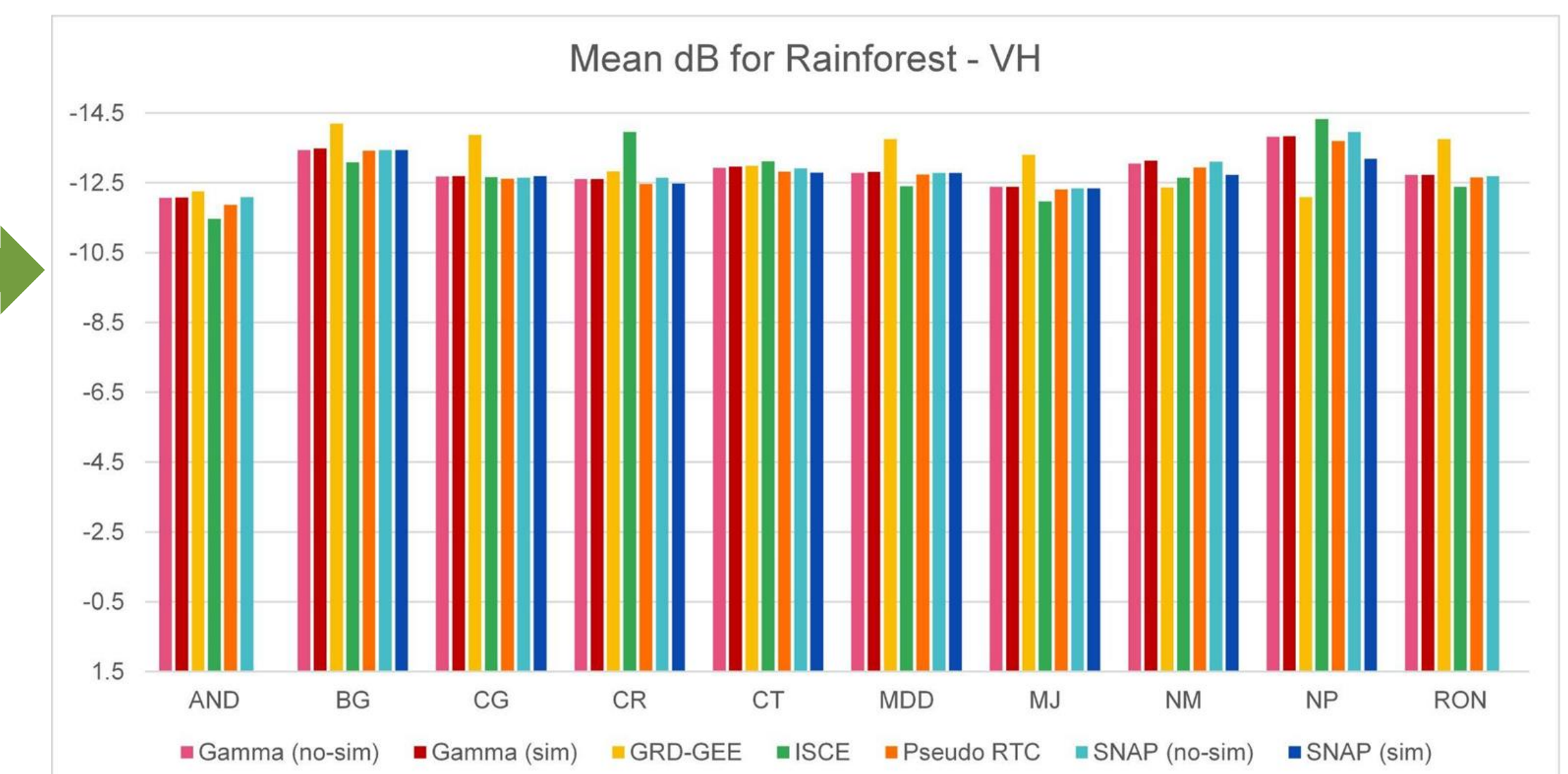
Radiometric Evaluation		Comment
Rainforest expected dB values	VV : -6.5dB	Over stable Amazon rainforest area evaluate average dB values for multiple RTC products
	VH: -12.5dB	
Topographic normalization	Slope of linear regression function (optimal slope should be 0, to show no dependence on local angle of incidence)	Backscatter compared to the local incidence angle and slope at each pixel location in evergreen forest areas
	Coefficient of variation (CV) (to quantify the scattering around the mean backscatter as an indicator of insufficiently corrected pixels)	

All RTC products analyzed were an improvement over GRDs for all metrics. SNAP-7 and ISCE-2 RTC products experienced geolocation offset, particularly in mountainous regions.

Geolocation Evaluation		Comment
Geolocation	Measurement of displacement	Using WV data as reference dataset

TIME SERIES		
Radiometric and geometric	Mean and standard deviation of backscatter [dB] (by product, polarization, month/season, and land cover class)	Create benchmark of monthly and seasonal variability of VV and VH for all products
	RMSE between each test product and Gamma product ("truth") as a function of time (by polarization and land cover class)	Compare as a function of underlying topography → stratify by flat terrain (0 to 12%) and steep slope (>20%)

5. Results



RTC Product	Avg(m)	Max(m)	Min(m)
Gamma	21.04	53.39	1.24
Gamma Sim	18.45	49.23	1.09
GTC	16.85	53.84	2.38
ISCE-2	40.38	111.74	5.92
Snap-7	17.26	73.93	0.00
Snap-7 Sim	47.84	117.57	9.78
GRD	710.66	49181.76	0.53

	Nepal		Madre de Dios	
Mean (db)				
Standard deviation (db)				

