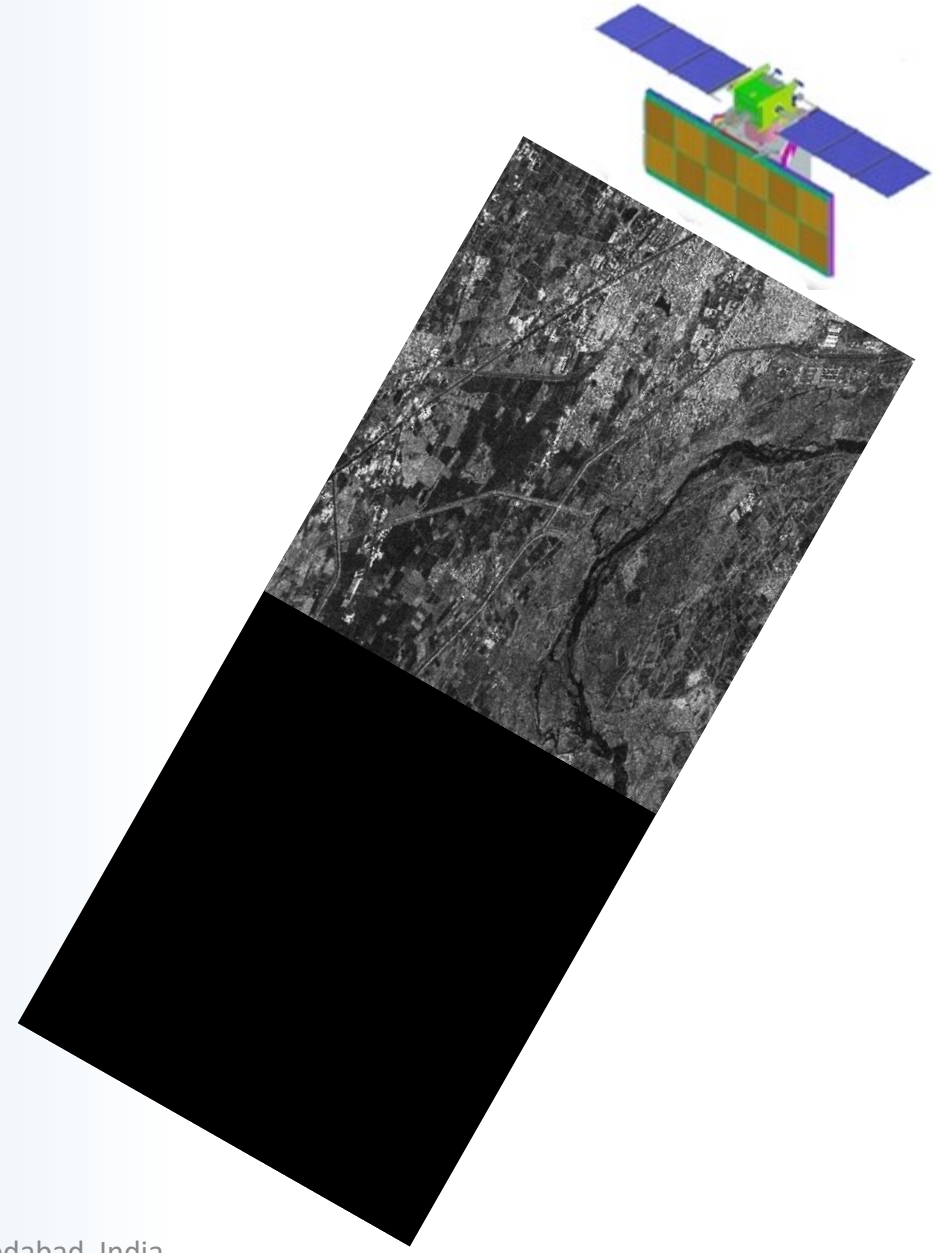
Site Suitability Analysis for Corner Reflector Deployment



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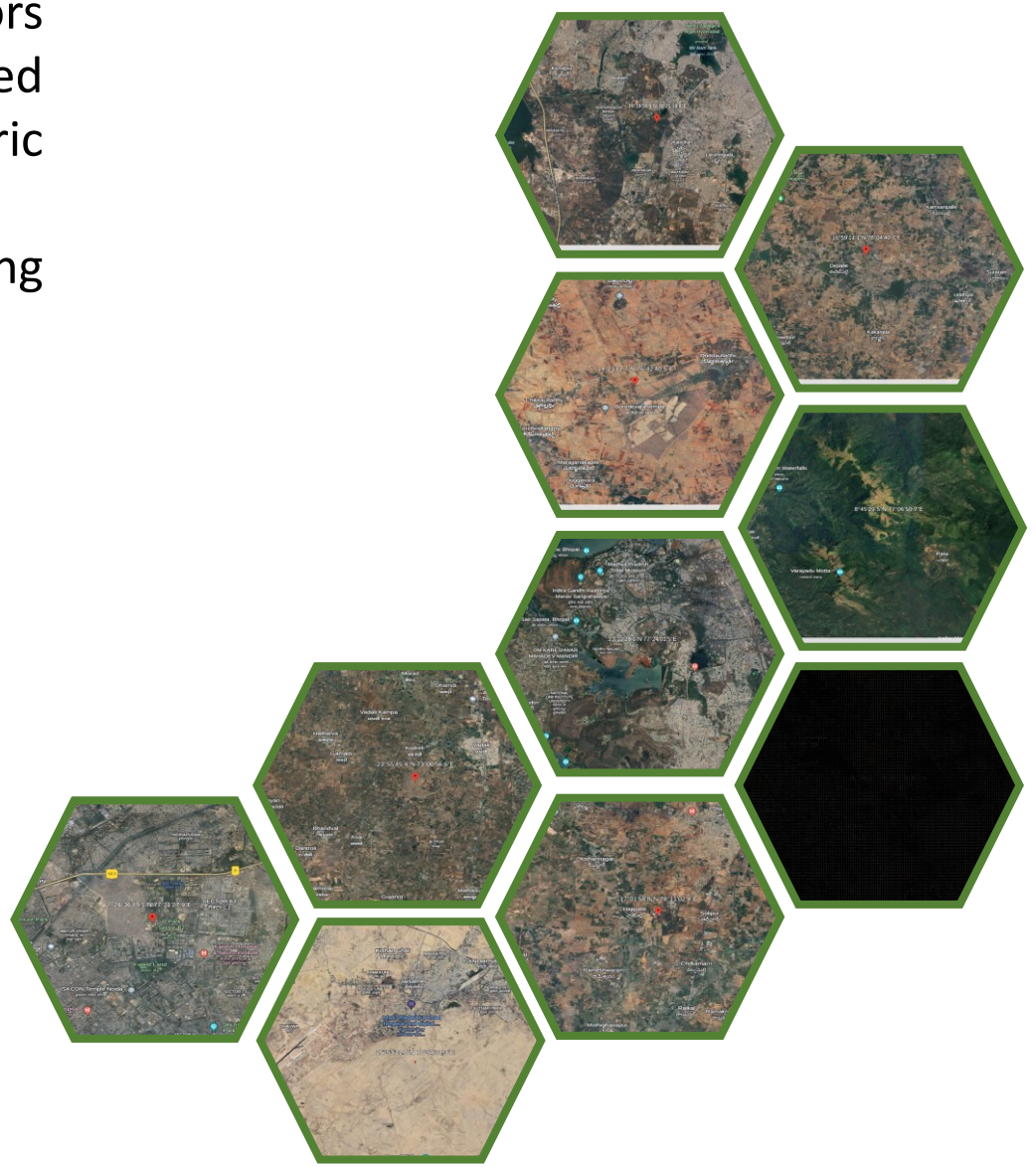
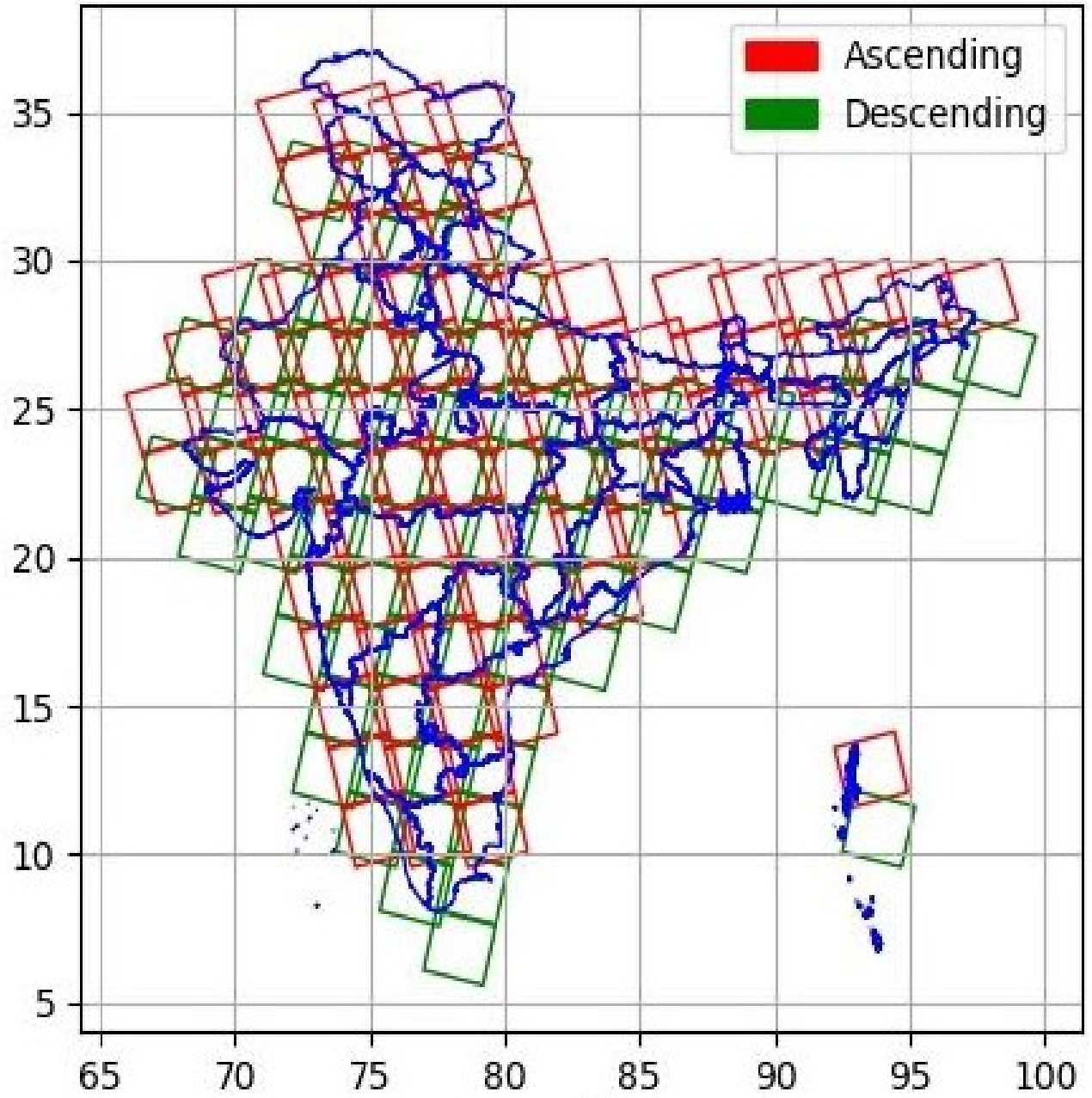
Introduction

- The calibration of SAR systems using corner reflectors (CRs) and extended targets is a well-established practice that ensures both radiometric and geometric accuracy.
- While selecting sites for CR deployment following points must be considered:
  - Uniform backscatter
  - Low background clutter
  - Consistent altitude



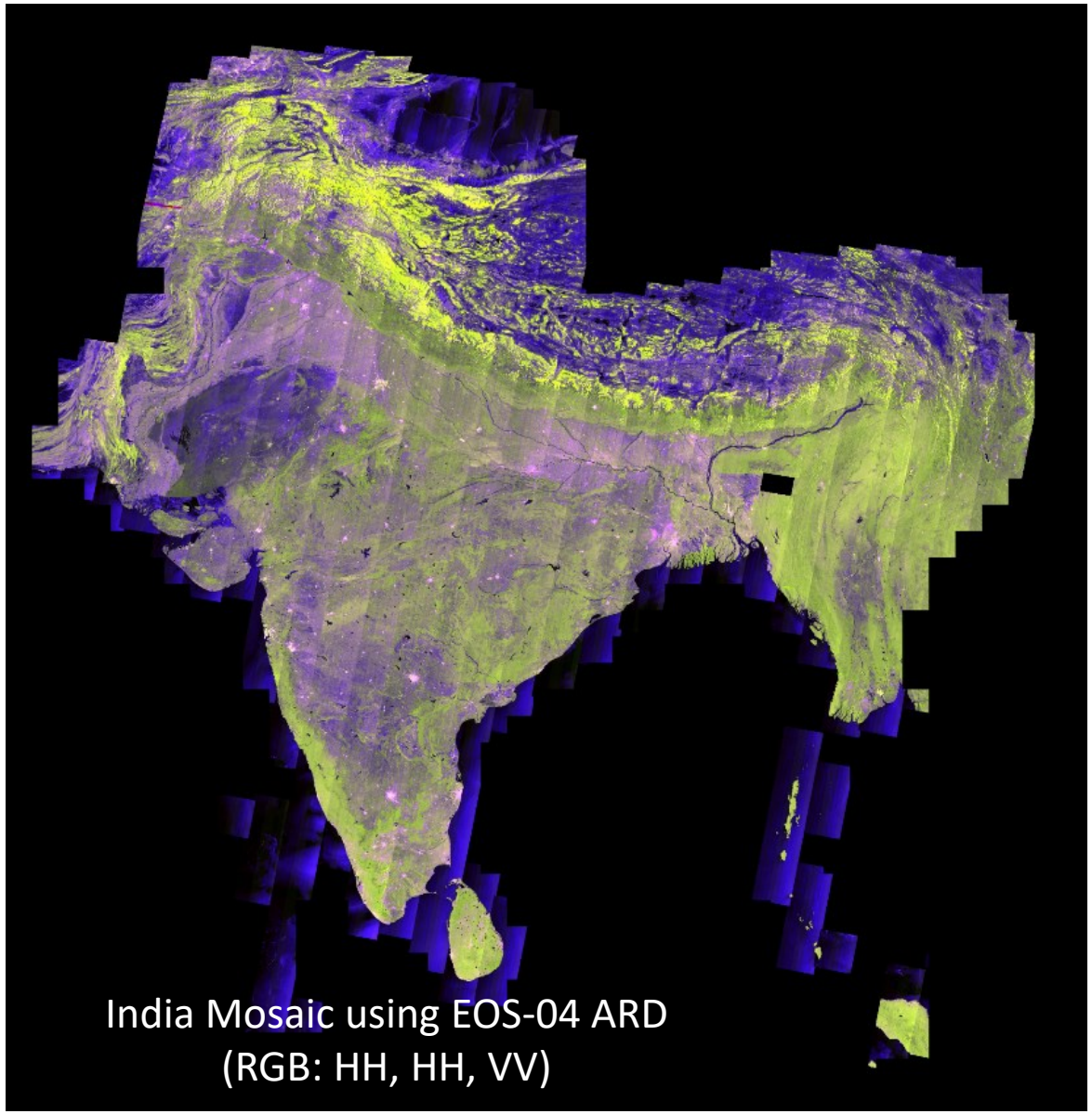
Motivation

- With availability MRS ARD India Mosaic, it gives opportunity to identify suitable location for corner reflector deployment.
- From different sources a consolidated list of candidate sites is present.
- This candidate sites must be qualified based on
  - Extent the site covers
  - Temporal behavior
- Due to systematic coverage and large swath/multiple beams, automation of the process of site qualification is required
- For this an approach is formulated to automatically identify/qualify site location for CR deployment.



Datasets Used

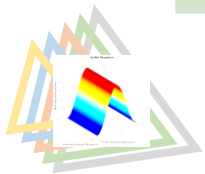
- **EOS-04 India Mosaic data product**
  - MRS Systematic coverage is used to carry out this analysis.
  - Tiled Normalized Radar Backscatter Analysis Ready Gamma0 product at 18 meters spacing available at interval of 17 days for full India
  - Cycle 39 (Dec 2023 – Jan 2024) and Cycle 48 (May 2024 – Jun 2024) is used.
  - Precise geometric registration across MRS cycles makes the product useful for Time-series analysis.
- **Copernicus DEM of 30m resolution**
- **22 Sites location (Tentative) identified by (NISAR) Calibration team is used as input**



India Mosaic using EOS-04 ARD
(RGB: HH, HH, VV)

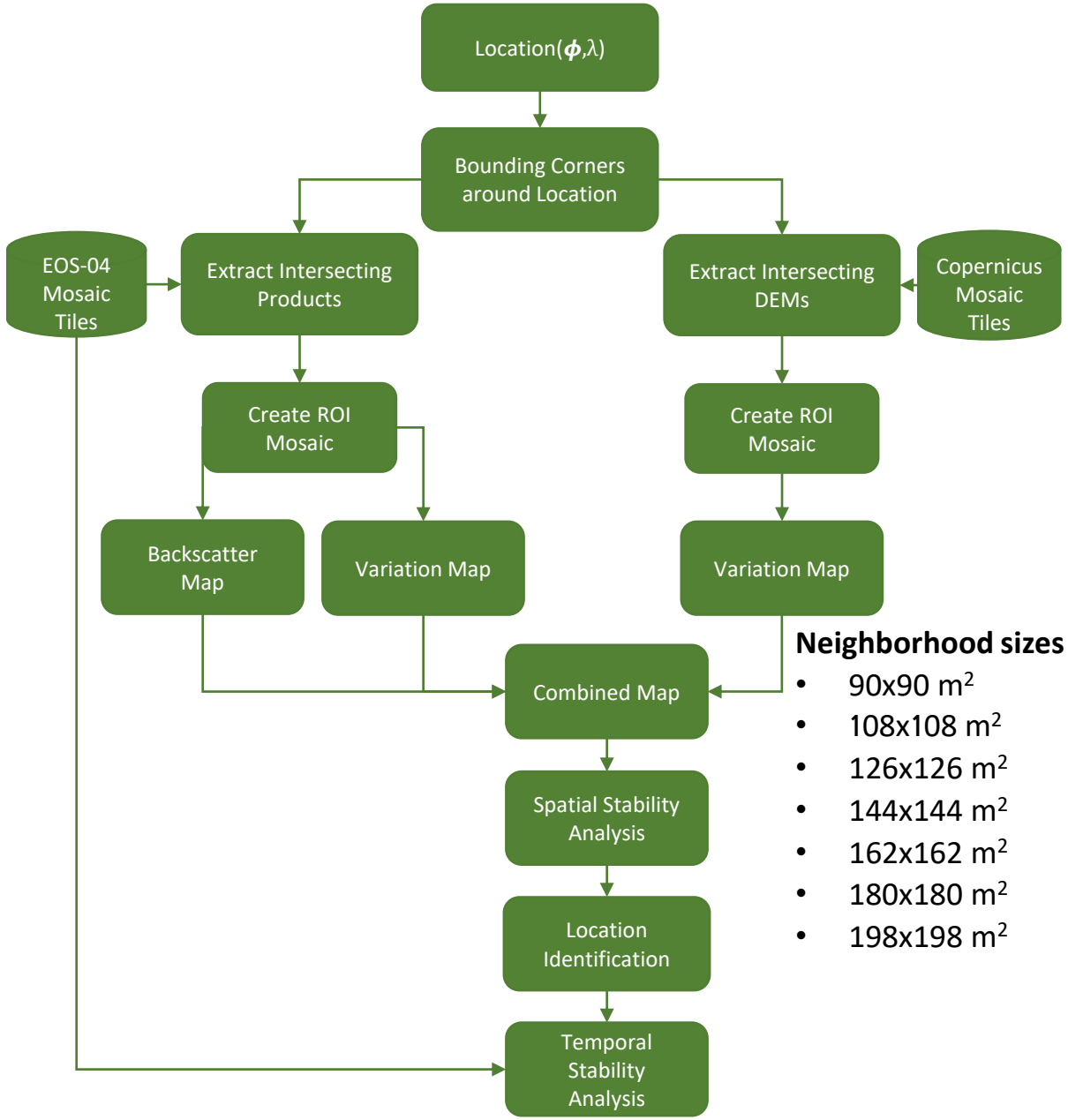
Datasets Used…

Sr. No.	Location	Sr. No.	Location
1.	Prof Jayashankar Telangana State Agricultural University, Hyderabad, Telangana	12.	CAZRI, Jaisalmer, Rajasthan
2.	Depaalle Village, Nawabpet Mandal, Telangana	13.	ERAD, (CA National Inst. Himalayan environment), Leh, J&K
3.	HSP, Chitra Durga, Karnataka	14.	IIT Kharagpur, West Bengal
4.	IIST, PONUMUDI, Kerala	15.	Amrapur, Gujarat
5.	RSAC, Bhopal MP	16.	LRK, Gujarat
6.	Vadali, Gujarat	17.	Lanela, Rajasthan
7.	IIT Kanpur, outreach center, Noida, UP	18.	Bap, Rajasthan
8.	IIT Kanpur, Kanpur, UP	19.	Desalpur, Gujarat
9.	NIT Raipur, CG	20.	Indus University, Ahmedabad, Gujarat
10.	Patan University, Patan. Gujarat	21.	SAC SRC, Ahmedabad. Gujarat
11.	IIT, Ropar, Rupnagar, Punjab	22.	SAC Bopal, Ahmedabad, Gujarat



Methodology

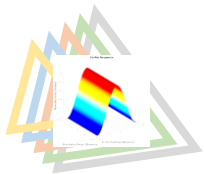
- **Inputs**: tentative site location($\boldsymbol{\phi}$,$\boldsymbol{\lambda}$), EOS-04 mosaic ARD, and the Copernicus DEM.
- For each location($\boldsymbol{\phi}$,$\boldsymbol{\lambda}$), intersecting products are fetched to create a ROI mosaic of the EOS-04 ARD and DEM.
- Variation maps are generated for both the image and DEM varying kernel sizes.
- Variation maps are combined into a composite map is created precise location is identified based on a minimum combined variance.
- The identified location is analyzed for temporal stability.
- The discussed methodology is followed for all the listed sites.
- ($\boldsymbol{\phi}^*$,$\boldsymbol{\lambda}^*$) = $\text{argmin}_{\boldsymbol{\phi},\boldsymbol{\lambda}}$ (Combined Variational Map)
- Sites with Combined Variational Map($\boldsymbol{\phi}^*$,$\boldsymbol{\lambda}^*$) < τ is accepted for that neighborhood size.



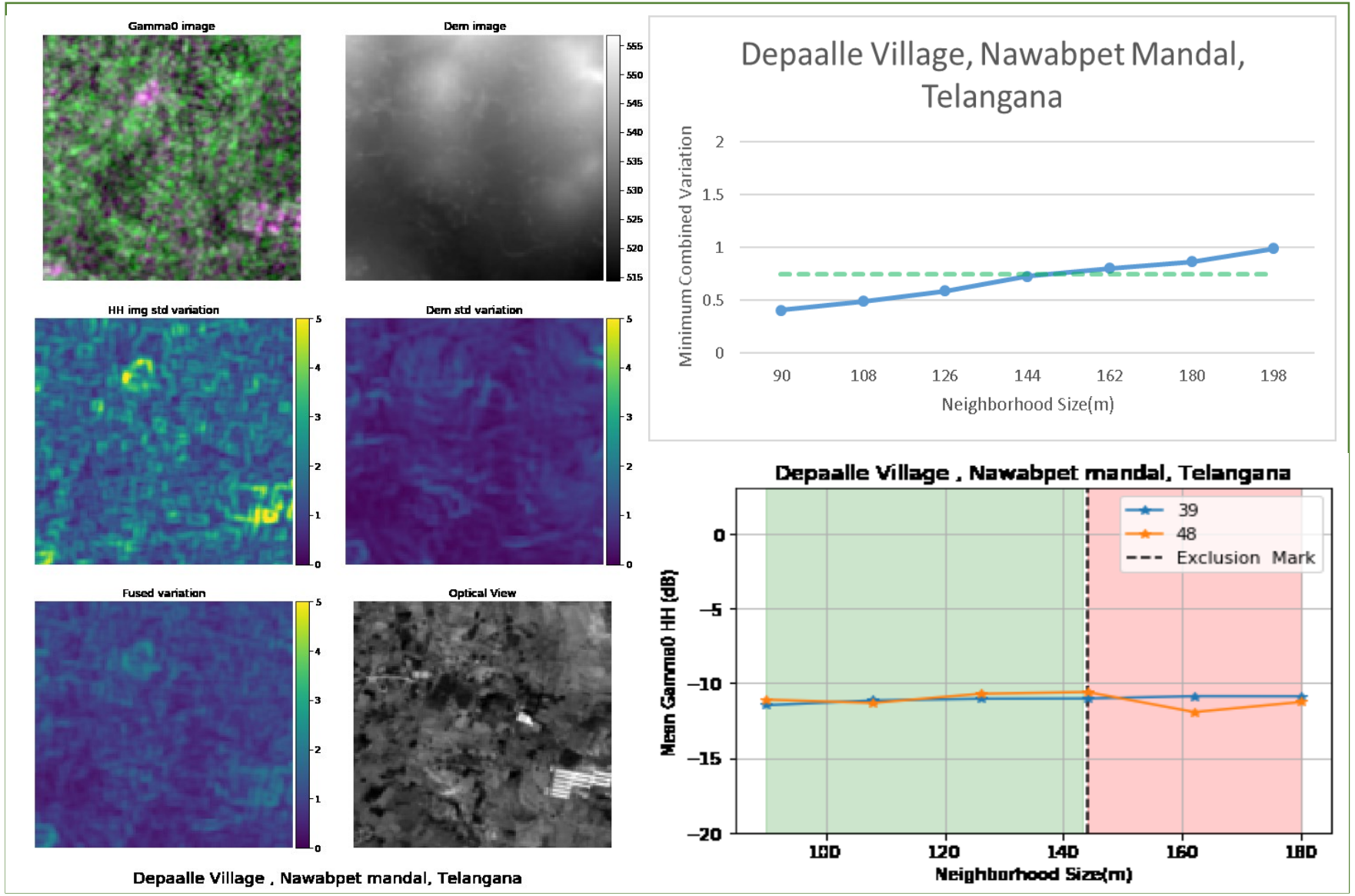
Results

Minimum Combined Variation

Kernel Size	5X5	6X6	7X7	8X8	9X9	10X10	11X11
Neighborhood Size(m)	90	108	126	144	162	180	198
Professor Jayashankar Agriculture University, Hyderabad, Telangana	0.66952	0.72137	0.84462	1.00760	1.12933	1.22450	1.30513
Depaalle Village , Nawabpet, Telangana	0.42952	0.65026	0.74651	0.83921	0.92595	1.02101	1.10369
HSP, Chitra Durga, Karnataka	0.59708	0.79622	0.94379	1.01387	1.07509	1.17624	1.29561
IIST, PONUMUDI, Kerala	1.89280	2.30732	2.68251	3.09577	3.37940	3.74498	4.15502
RSAC, Bhopal, MP	0.54205	0.72619	0.85653	0.93970	1.05957	1.17503	1.33330
Vadali, Gujarat	0.47929	0.59413	0.71402	0.82063	0.92352	0.95895	1.00588
IIT Kanpur, Outreach Center, Noida, UP	0.50708	0.61969	0.79063	0.88137	1.04313	1.19843	1.40456
IIT Kanpur, Kanpur, UP	0.26107	0.31709	0.36429	0.41101	0.43577	0.45203	0.48006
NIT Raipur, CG	0.32982	0.37577	0.42195	0.46049	0.48519	0.50063	0.55885
Patan University, Patan, Gujarat	0.61411	0.76311	0.85570	0.95256	1.03527	1.14180	1.24010
IIT, Ropar, Rupnagar, Punjab	0.24103	0.26008	0.32622	0.38314	0.43579	0.50126	0.53115
CAZRI, Jaisalmer, Rajasthan	0.34719	0.42996	0.51468	0.62114	0.71189	0.76780	0.83709
Erad Leh, Ladakh	0.00000	0.00000	0.64406	0.89872	1.07126	1.19636	1.30739
IIT Kharagpur, West Bengal	0.38827	0.47917	0.55212	0.61000	0.67765	0.75928	0.83153
Amrapur, Gujarat	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LRK, Gujarat	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Lanela, Rajasthan	0.36899	0.46306	0.51091	0.55576	0.61597	0.63917	0.65316
Bap, Rajasthan	0.30101	0.32060	0.37478	0.40709	0.41409	0.43321	0.44580
Desalpur, Gujarat	0.20743	0.25185	0.28677	0.31106	0.34206	0.38605	0.40191
Indus University, Ahmedabad, Gujarat	0.44046	0.61141	0.66761	0.77344	0.98125	1.25320	1.49552
SAC SRC, Ahmedbad, Gujarat	0.60237	0.68880	0.87625	1.17813	1.41895	1.57099	1.72027
SAC Bopal, Ahmedabad, Gujarat	0.55337	0.68567	0.80668	1.01088	1.07349	1.10797	1.13562

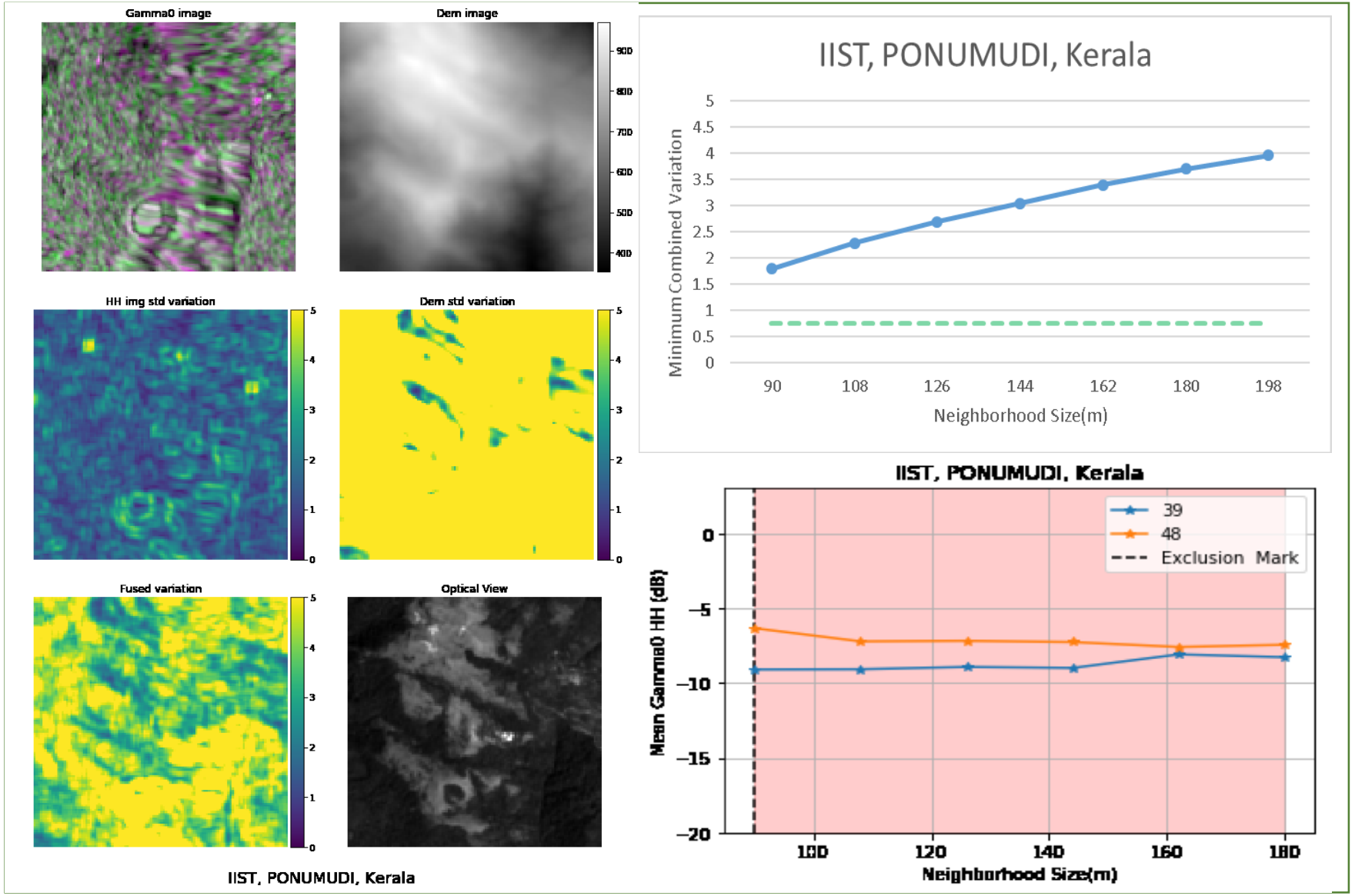


Results



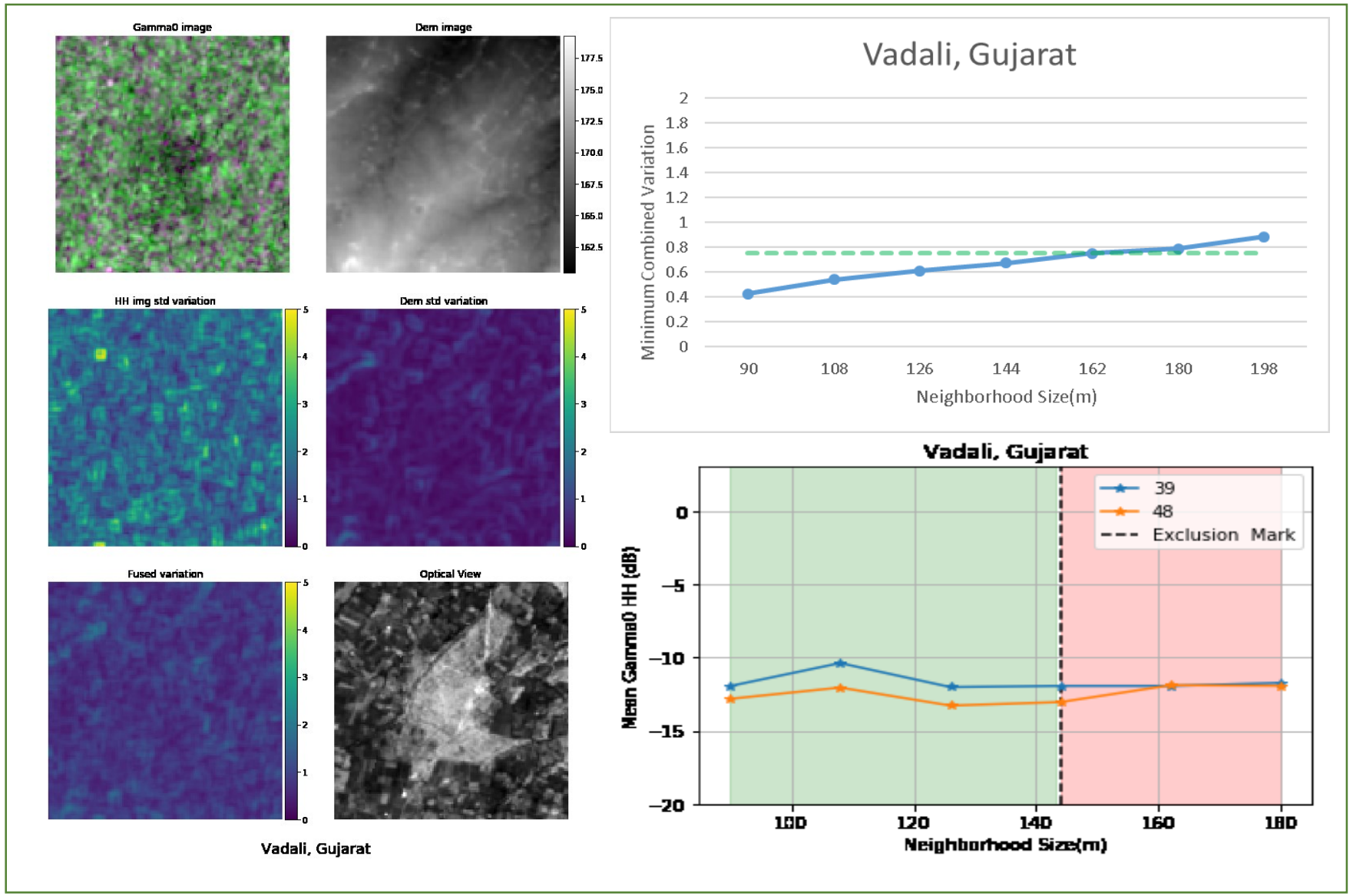
- Depaalle Village is qualified for neighborhood size < τ 144x144 m^2
- The backscatter coefficient was found to be below -10 dB.
- So, we conclude that it can be used for high resolution to medium resolution images.

Results



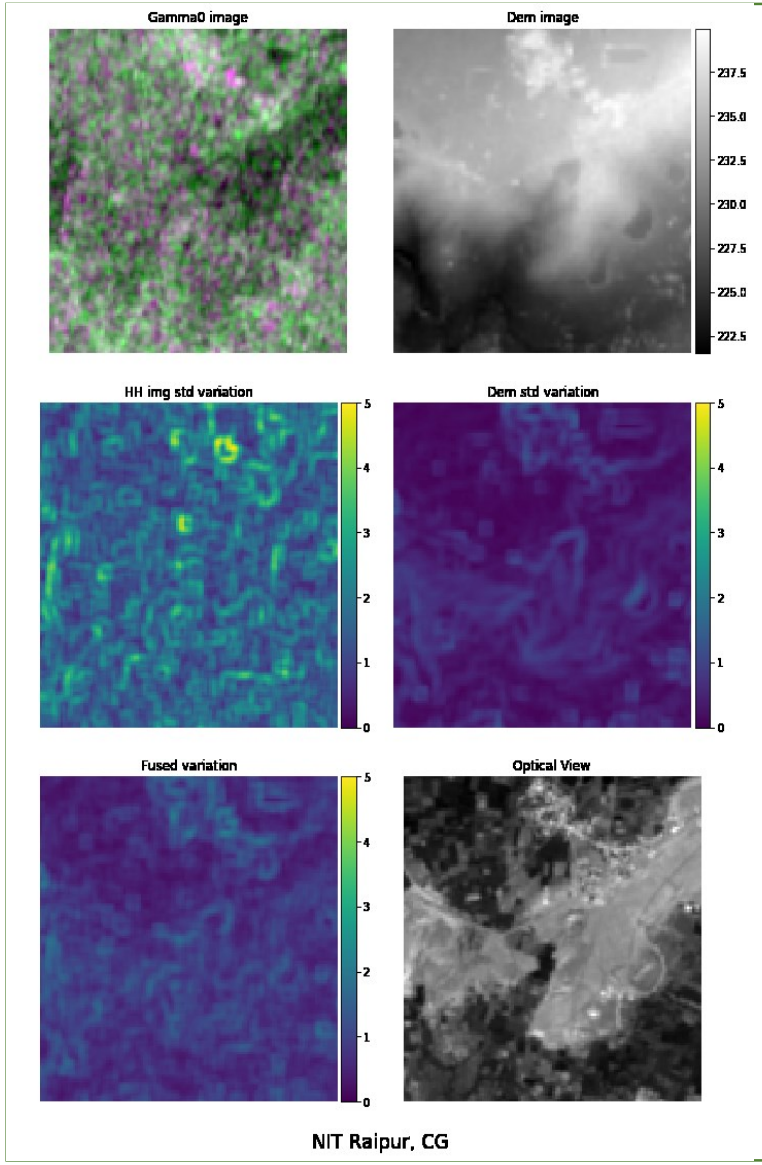
- IIST, Ponumudi shows combined > τ for all neighborhood sizes.
- So, we conclude that it cannot be used CR deploeyment.

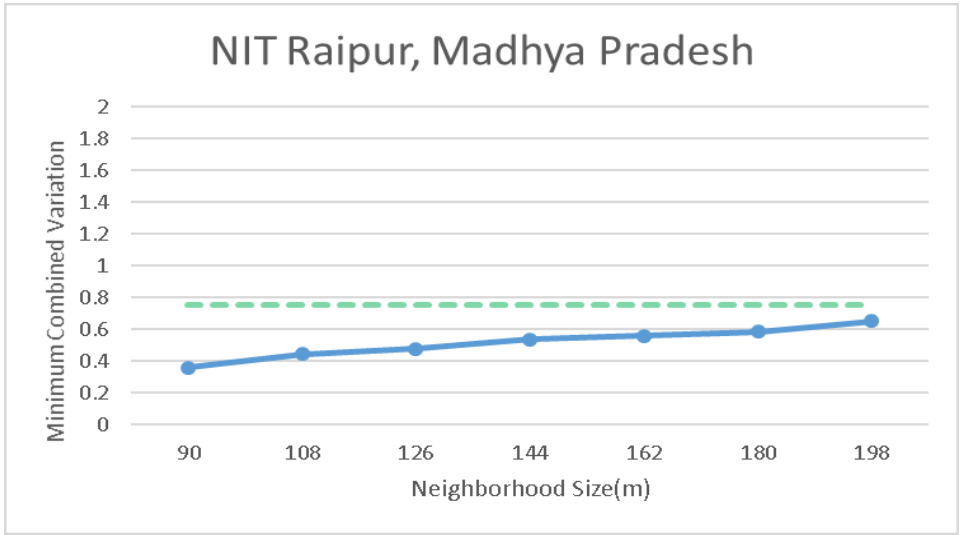
Results

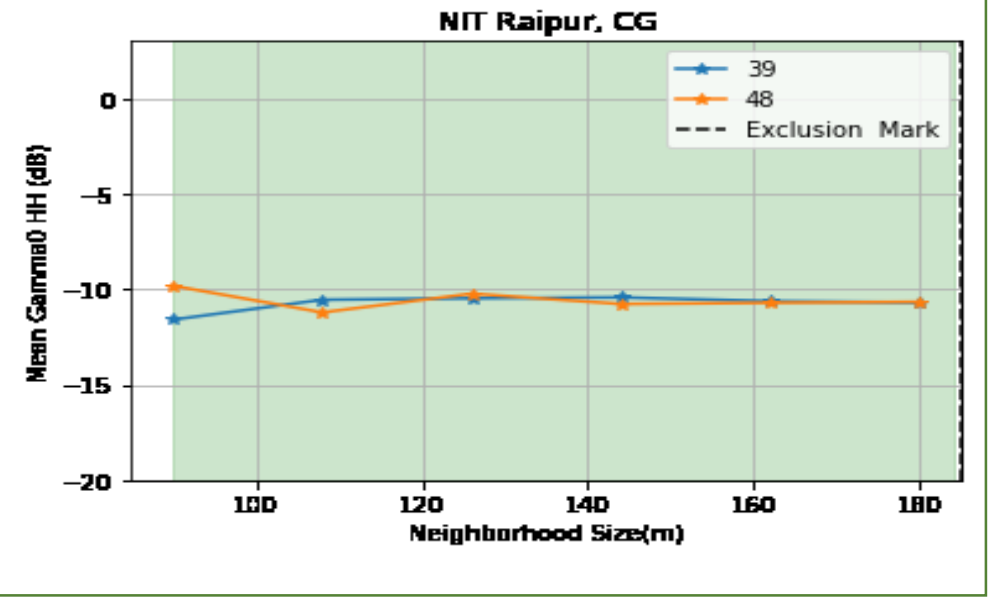


- Vadali, Gujarat is qualified for neighborhood size < τ 144x144 m^2
- The backscatter coefficient was found to be below -10 dB.
- So, we conclude that it can be used for high resolution to medium resolution images.

Results

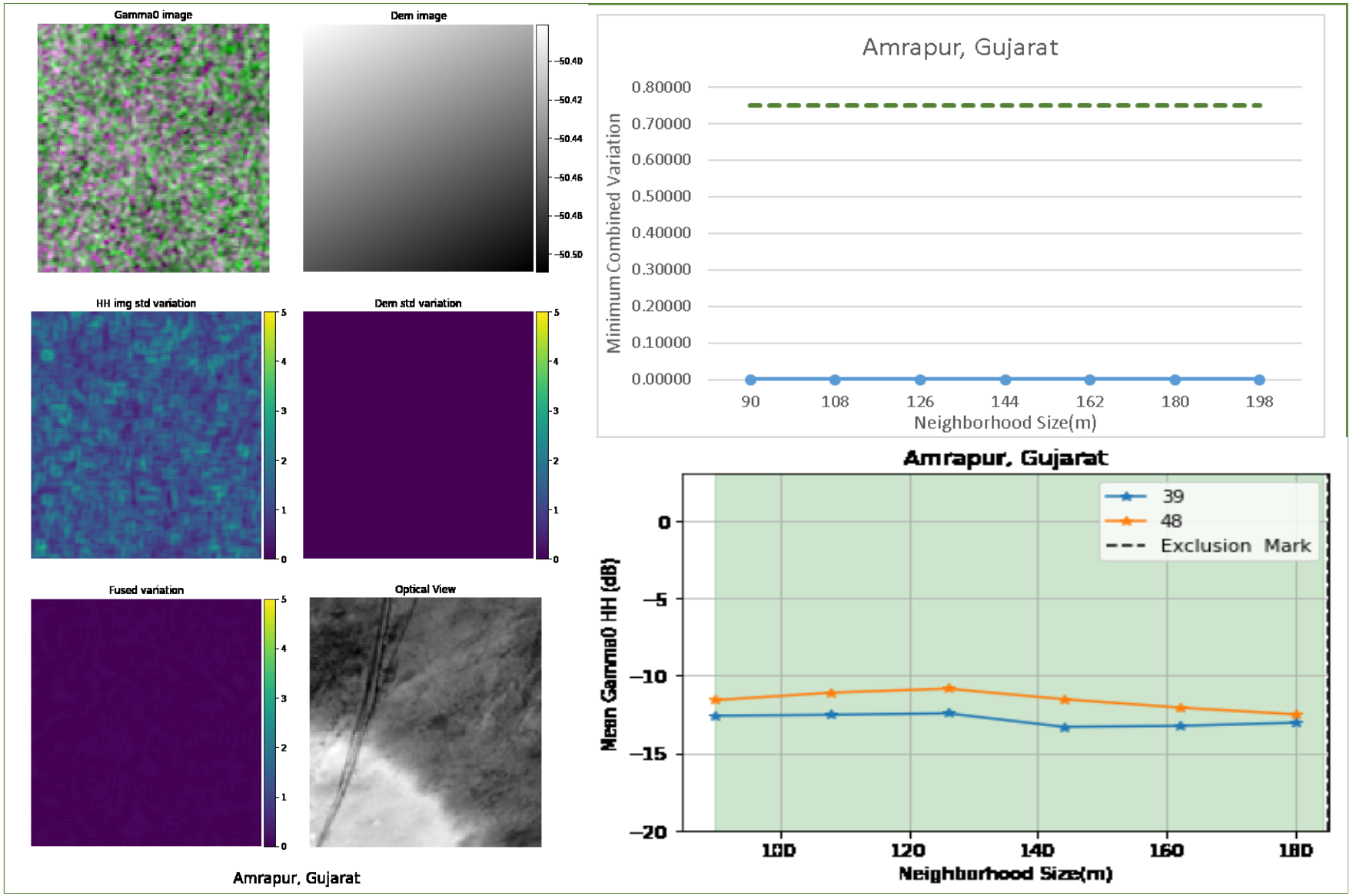






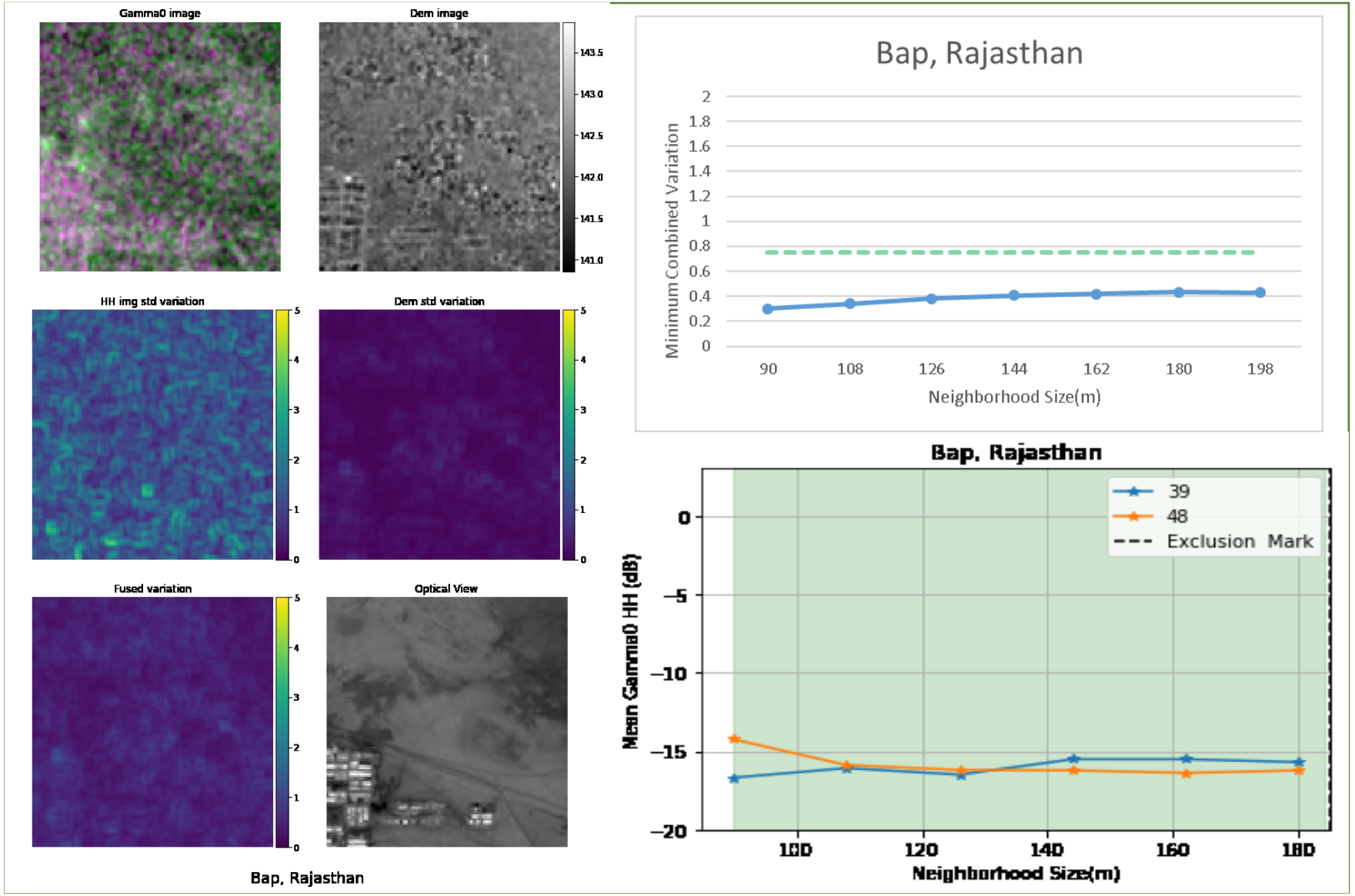
- NIT Raipur, Madhya Pradesh shows that minimum value of combined variational map < τ for all neighborhood size.
- The backscatter coefficient was found to be below -10 dB.
- So, we conclude that it can be used for CR Deployment for all resolution images.

Results



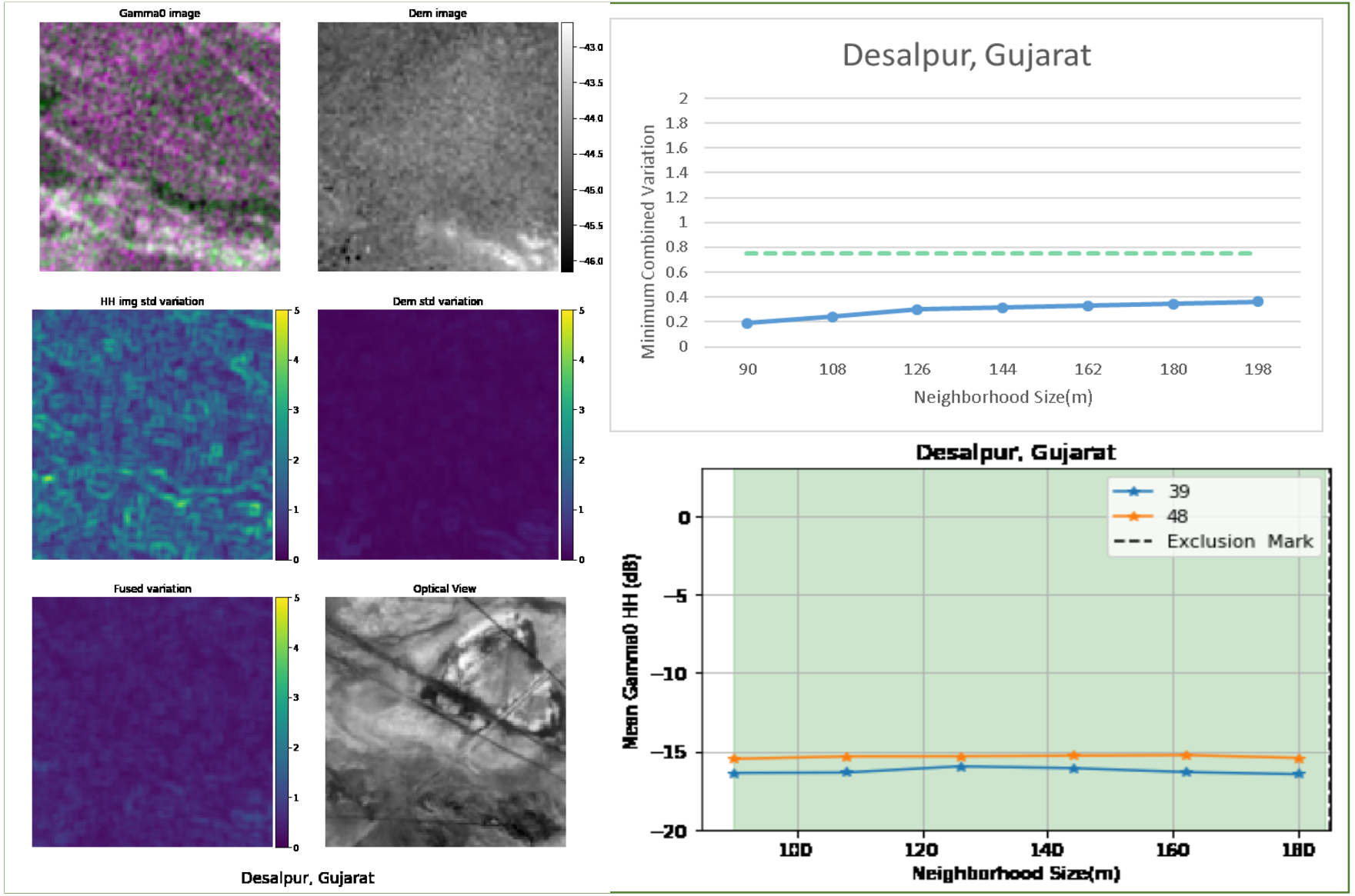
- Amrapur, Gujarat shows that minimum value of combined variational map $< \tau$ for all neighborhood size.
- The backscatter coefficient was found to be around -12 dB.
- So, we conclude that it can be used for CR Deployment for all resolution images.

Results



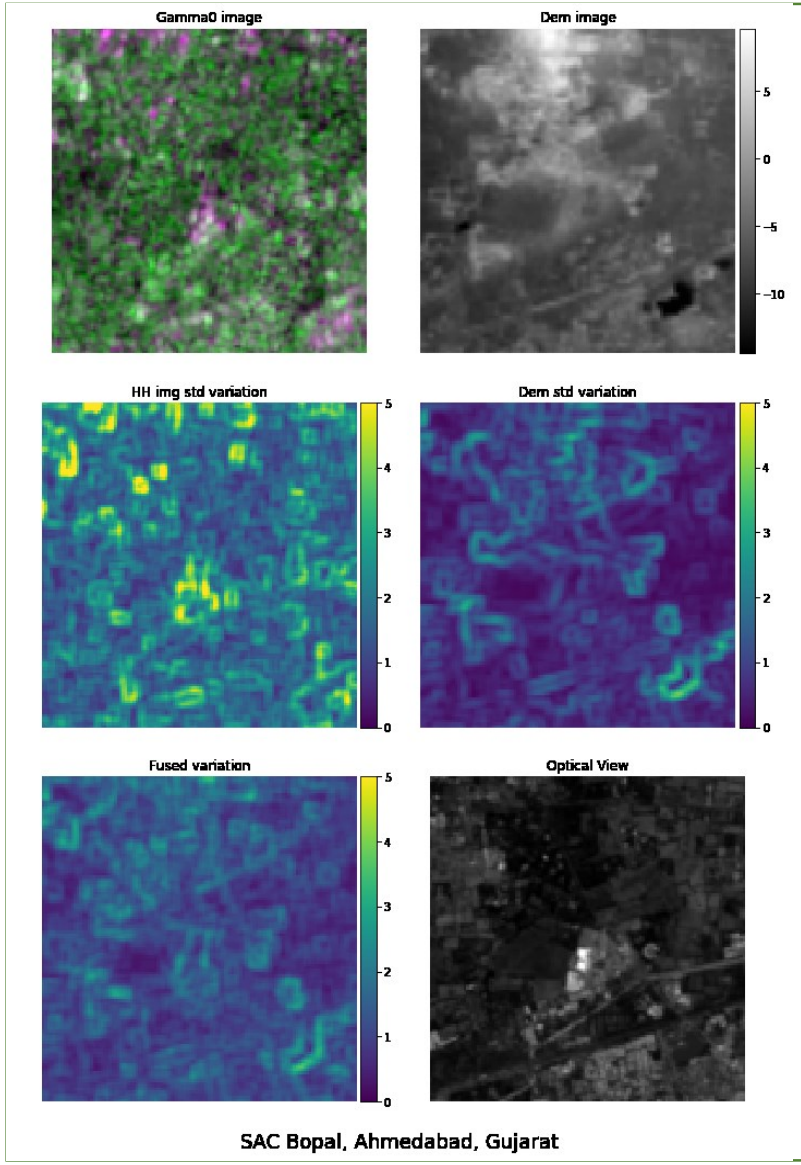
- Bap, Rajasthan shows that minimum value of combined variational map is less than τ for all neighborhood size.
- The backscatter coefficient was found to be around -15 dB.
- So, we conclude that it can be used for CR Deployment for all resolution images.

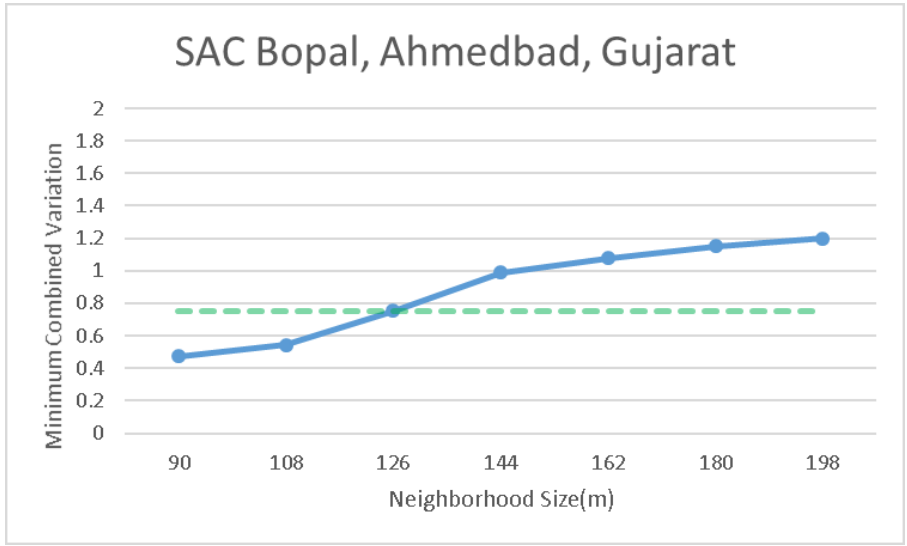
Results

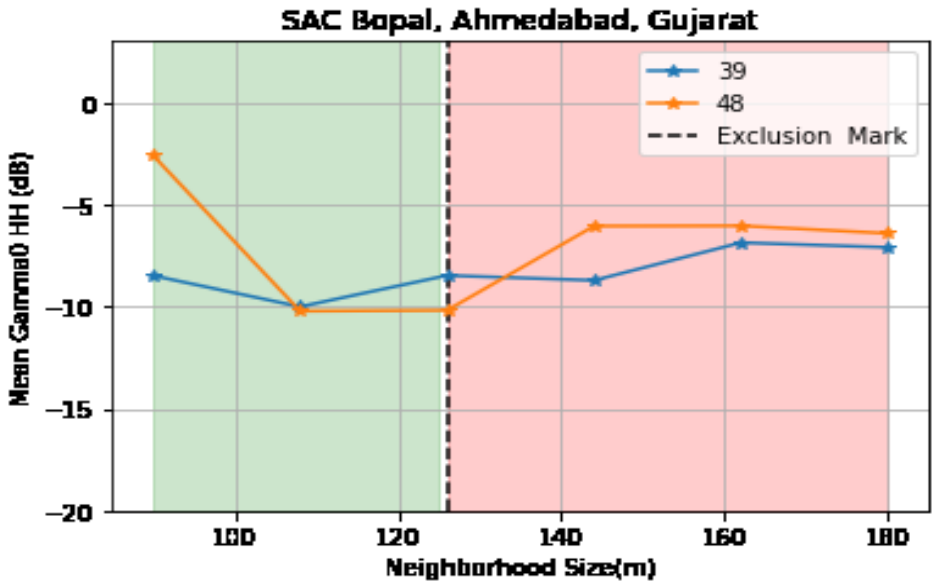


- Desalpur, Gujarat shows that minimum value of combined variational map is less than τ for all neighborhood size.
- The backscatter coefficient was found to be below -15 dB.
- So, we conclude that it can be used for CR Deployment for all resolution images.

Results



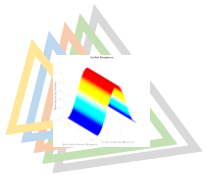




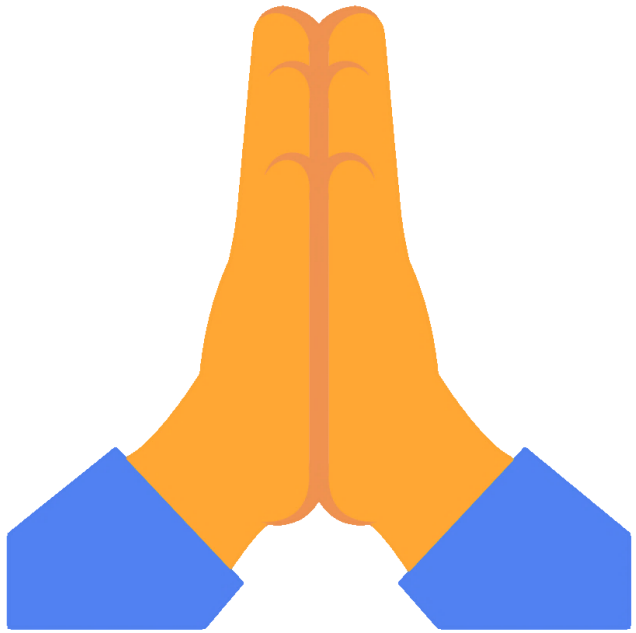
- SAC Bopal, Gujarat is qualified for neighborhood size < τ 126x126 m^2
- The backscatter coefficient was found to be varying a lot and very less stable.
- No conclusive evidence can be derived for utilization of the site.

Conclusion

- All identified sites, are found suitable for high-resolution SAR, except the fourth site (IIST,PONUMUDI, Kerala)
- Sites exhibiting a minimum combined variance less than 0.75 and fulfilling the requirement of window used for CR data analysis are appropriate for the deployment of CR for the given sensor.
- Sites like IIT Kanpur, IIT Ropar, Amrapur, LRK, Lanela, Bap, Desalpur have potential to support medium resolution SAR calibration.
- Also, high spatial invariability for the larger area suggests the possibilities of these sites to be monitored as an extended target which can be further explored
- Temporal stability behavior of Gamma-0 is observed from data taken from two cycles (December and August) for all the sites and neighborhood size. This needs further analysis using more temporally separated cycles



Thank You



Results…

- Identified Sites for Ascending and Descending track frames for whole india.