Performance evaluation of deployed corner reflectors in Antarctica for SAR radiometric calibration quality assessment

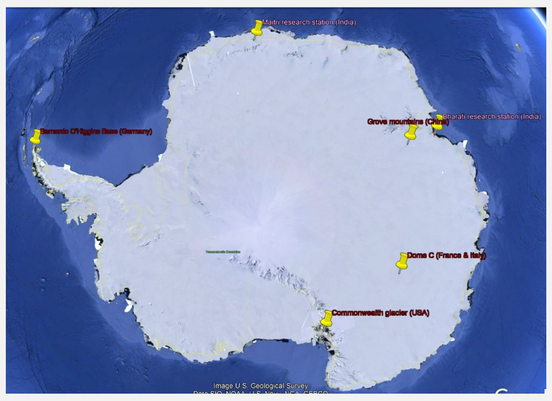
Shweta Sharma[1], Sowkhya Badatala[2], Ritesh Agrawal[1], Saurabh Tripathi[1], Sushil Singh[1], Parul R Patel[2], Arup Hait[1] and Shailendra Saini[3]

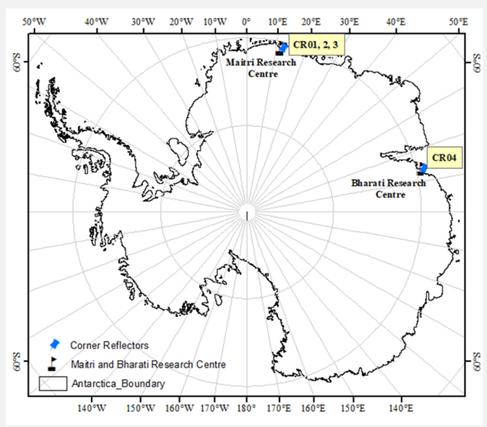
1Space Applications Centre, ISRO, Ahmedabad 380015, Gujarat, India
2Institute of Technology, Nirma University, Ahmedabad 382481, Gujarat, India
3Civil Engineering Department, Indian Institute of Technology Kanpur, Kanpur 208016, Uttar Pradesh, India

shweta@sac.isro.gov.in

Objectives:

To evaluate the performance of the CRs deployed in the surroundings of Schirmacher Oasis (Maitri Indian research station) and Larsemann Hills (Bharati) in Antarctica in terms of their temporal Radar Cross Section stability and to assess its potential use for SAR calibration and InSAR applications.





S.No.	Country	Corner reflectors type, number	Year of installation and Location in Antarctica	Applications for which CRs are being used	Remarks
1.	Germany	4, Triangular trihedral 2, Triangular trihedrals (0.7 m)	1995-1996, near Schirmacher oasis (near Wohlthat) 2013	To validate interferometrically derived Ice velocity Calibration, to evaluate the localization accuracy of the TerraSAR-X mission	 Permanent installation
2.	USA	2, Triangular trihedrals	2002, Commonwealth glacier, Taylor Valley	To define the transact in the image for mass-balance studies	Campaign mode
3.	China	 3+2,	2005-2006, Grove mountains (~400 km away from Zhongshan station) 2015, 2019, ~1200 km CHINARE route from Zhongshan station to Junkun station	DEM generation, Ice-flow velocity estimation. To validate the ice flow velocity derived from SAR images	 Permanent
4.	France and Italy	9,	2007-2008, Dome C	Interferometry related studies. The main purpose of INSAR on the ice is to measure surface velocity, topography and ice ocean interaction.	Permanent installation
5.	India	5, Triangular trihedrals	2018-2022, 4 near Maitri research station , one near Bharati	SAR data calibration	Permanent

Methodology:

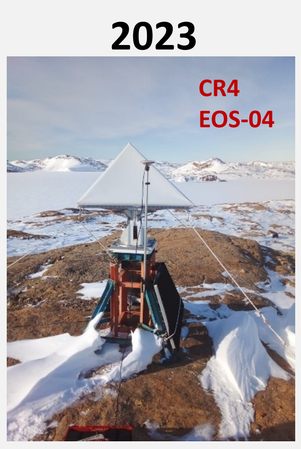
RCS of the CR was computed using the Integral power method and analyzed over time. Signal-to-Clutter Ratio (SCR) was also estimated using the time-series response of the permanent CRs in Interferometric wide (IW) swath mode data of Sentinel-1A. It was then used to predict the InSAR phase variance. Five CRs are currently deployed in Antarctica (four near Maitri and one near Bharati).

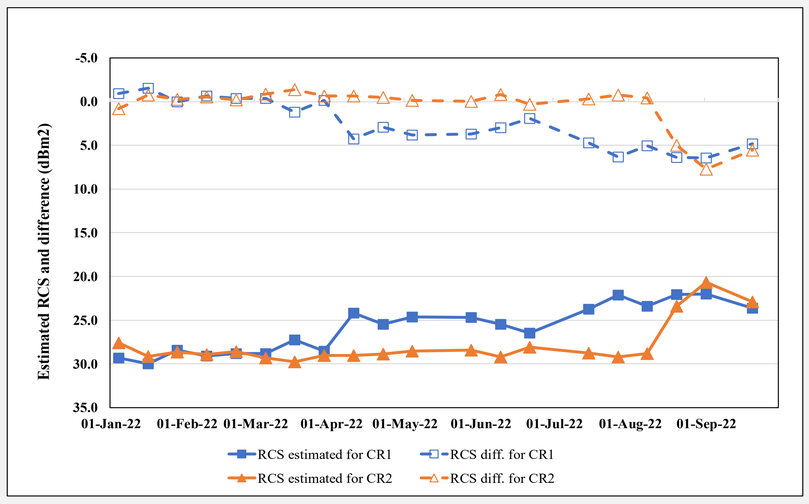
$$\varphi_{error} = \frac{1}{\sqrt{2 * SCR}} \qquad LOS_{error} = \frac{\varphi_{error}\,\lambda}{4\pi}$$

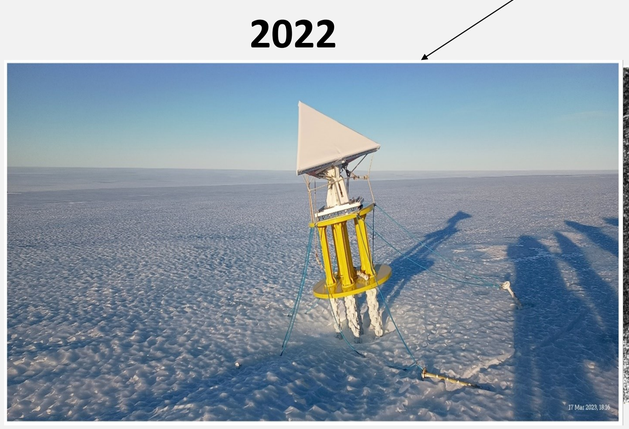
Results:

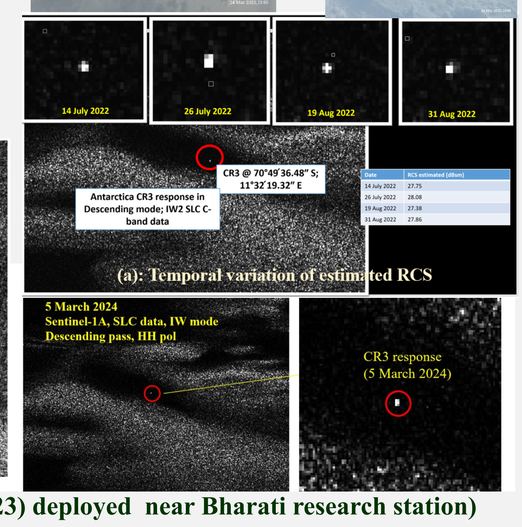
Evaluation of the response in SAR data (Sentinel-1 and EOS-04) show consistent response for the two CRs deployed at rocky base and one CR deployed at the ice sheet.

Ground snap of CR deployed at ice sheet (L) and near Maitri station (R)

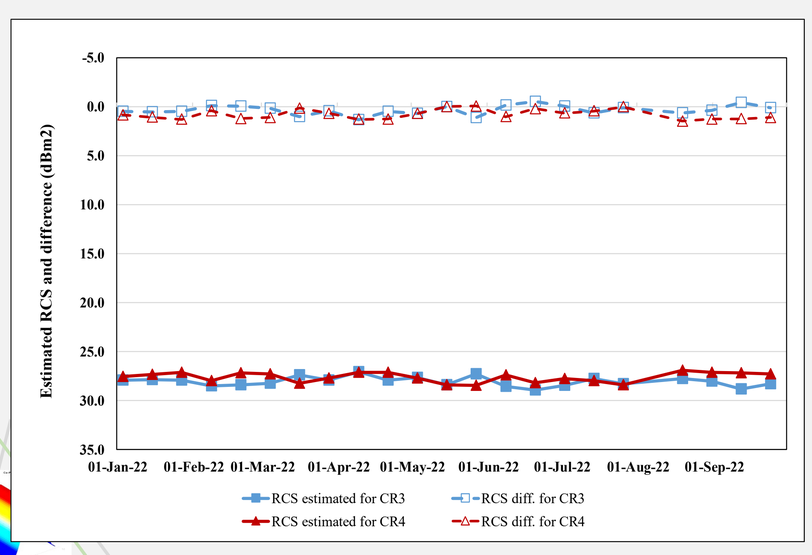








EOS-04 (FRS-2, 16 February 2023) deployed near Bharati research station)



- **Snow accumulation was observed at the CR deployed at far range in the NISAR simulated footprint.**
- **The study showed the need of customization in the design of the supporting mount to make it robust.**
- **The mean phase error was estimated to be 7.38 degrees and the a priori estimate of LOS error estimated was 0.57 mm, both within the acceptable limits.**
- **It is planned to use CRs deployed near Maitri and Bharati for geometric calibration quality assessment.**