JOINT ISRO-DLR SAR CAMPAIGN OVER INDIA: MISSION GOALS AND FIRST RESULTS

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As a part of scientific collaboration between Indian Space Research Organisation (ISRO) and German Aerospace Center (DLR), an extensive DLR-Experimental SAR (E-SAR) campaign was conducted over various sites spread over India. This campaign was conducted during September 13 to October 2, 2004 using DLR's DO-228-212 aircraft and E-SAR equipment with multi-parametric SAR. Two test and calibration missions – one each for pre- and post- data collection missions were carried out for testing and calibrating all bands/polarisations of E-SAR equipment. The campaign was completed using 15 flight missions from 7 airports as local bases. In addition, 8 ferry flights were required to position the aircraft and two more airports were used for refueling for two west-east and east-west ferry flights. The DLR aircraft arrived at Ahmedabad, India (the main base) on September 8, 2004 and left India on October 8.

Space Applications Centre, Ahmedabad, was the coordinating centre of ISRO assisted by NRSA, Hyderabad and various RRSSCs. The entire flight mission duration was restricted to 60 hours as 40 hours were spent in ferrying of the DLR aircraft from near Munich to Ahmedabad and its return.

E-SAR is a Synthetic Aperture Radar (SAR) system onboard a DLR Dornier DO 228 aircraft. The sensor operates in multiple frequency bands. The polarisation of the radar signal is selectable, horizontal as well as vertical. In polarimetric mode the polarisation is switched from pulse to pulse.

E-SAR offers high operational flexibility. The measurement modes include single channel operation, i.e. one wavelength and polarisation at a time, and the modes of SAR Interferometry and SAR Polarimetry. The system is polarimetrically calibrated in the lower frequency bands. SAR Interferometry is operational in X-band (XTI and ATI). Repeat Pass SAR Interferometry is operational in lower frequency bands, especially in combination with polarimetry.

A modern RT-DGPS/INS System (IGI CCNS4/Aerocontrol IId) combined with a FUGRO OmniStar DGPS receiver allows most precise navigation and positioning. E-SAR is hence able to generate geocoded image products of very high geographical precision. Repeat Pass SAR Interferometry at baselines of less than 10 m is possible.

Part of the sensor system is an operational E-SAR ground segment. After transcription from HDDC (SONY SD-1) to hard disk drive the E-SAR ECS-Processor converts the SAR data to calibrated image data products. To increase the product quality level to CEOS level 1 b3 radiometric and polarimetric calibration, DEM generation and geo-coding are operationally implemented.

E-SAR data pre-processing was completed at SAC by October 16 by DLR and SAC scientists using hardware/software developed at DLR. SAR processing of all data collected has been completed at SAC by December, 2004 while the generation of geo-referenced data has been completed by March 2005 using software developed at DLR. The multi-parametric SAR data set is geo-referenced to specified accuracy mentioned above.

The objective of the campaign included applications in agriculture, soil moisture, forestry, geology, physical oceanography, wetland, SAR interferometry (accurate DEM). All applications required multi-frequency/multi-polarimetric data. L and P band polarimetric-interferometric (using repeat-pass) applications were also part of the campaign. Detailed ground-truth data have been collected simultaneously with the E-SAR data collection along with DGPS for high location accuracy.

The data campaign included multi-parametric data collection in XXTI cross-track interferometry, CHH and CHV, polarimetric-interferometry (repeat pass) for the lower frequency bands as per the need of the study. Most of the data collection was in medium resolution mode (5 m resolution, 5 km swath) with a strip length of 20 km. All data collected show excellent radiometry and resolution. Lower-frequency band polarimetric data show maximum information content even for agricultural fields with standing crops. XTI data showed excellent interferometric fringe patterns and derived DEM. The repeat-pass polarimetric-interferometric data is showing immense information content.

The lower frequency polarimetric-interferometric data is new to applications in the use of SAR data. Use of combinations of multi-frequency data would open up new approaches to remote sensing investigations in the fields of agriculture, soil, forestry, geology, oceanography and other fields.