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Scatsat-1, A Globally Acclaimed Scatterometer: Advanced Features, Payload Characterization and Data Analyses

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Scatsat-1 is the ISRO's newest state-of-art microwave Scatterometer which has been launched on 26th Sep 2016 from ISRO's space-port Sriharikota onboard the PSLV C35 mission. It is an advanced follow-on of OScat, ISRO's first Scatterometer in space onboard the Oceansat-2 satellite which ceased to operate in March 2014. Scatsat-1 is highly rated by the international user community which includes NASA, NOAA, EUMETSAT and KNMI apart from the Indian users. Its data is being routinely used in generation of various wind-vector products across the globe which, in turn, serves operational weather forecasting, ocean state forecast, detecting cyclogenesis, tracking cyclones and predicting their landfall. This apart, the stability and accuracy of Scatsat-1 data have established its worth for inclusion in long term data records for climate studies.

Scatsat-1 was configured for the Indian Mini Satellite (IMS-2) bus. The Scatterometer payload is a two-beam, dual-polarized, conically scanning, pencil beam, real-aperture radar which measures near-surface wind-vectors over ocean exploiting Bragg scattering resonance at Ku-band. It has been developed in ISRO's Space Applications Centre in quick time to replace OScat. Although it inherits the instrument specifications from OScat, several improvements as well as new elements have been incorporated in its hardware. These include, among others, cross-patching between crucial main and redundant subsystems, miniaturization of the digital hardware, improvement in noise equivalent radar cross-section (σ^0), a two-stage digital filter with better passband slope and ripple replacing the analog band-limiting SAW filter at receiver output, 32-bit precision of onboard processed data unlike truncated 16-bit in OScat, 4K-FFT replacing 1K FFT (overlapped periodogram approach of OScat), new Rotary joint with fewer joints, lower insertion loss and less leakage, new scan-mechanism which provides higher torque with lesser current, and several ground-commanded flexible features in the onboard processor. These features will be elaborated in this paper. Further, several new payload characterization schemes were adopted in Scatsat-1 which proved worthwhile in establishing the quality of performance that Scatsat exhibits. Some of these techniques, which will be illustrated in this paper, are brightness temperature calibration of the noise measurements using ambient and cold targets on ground and deep space viewing data onboard, end-to-end characterization of the system response using active target simulator and characterization of the linearity of system response over the entire range of signal-to-noise ratio (SNR) using the Scatterometer principle of noise-subtraction itself.

Scatsat-1 has undergone an extensive as well as intensive calibration and validation phase. Its data have been subjected to rigorous analyses with respect to self-consistency, natural calibration targets such as the Amazon rainforest and other Scatterometers such as the ESA AScat. This paper will address some of the analyses carried out to evaluate the sensor performance. These include histograms of σ^0 over ocean accumulated during a repeat cycle to show balancing of range-slices, the slice-wise plots of percentage of negative σ^0 as function of SNR for authenticating the accuracy of noise estimation and correction and the linearity of SNR versus σ^0 across the entire dynamic range of the sensor, even at SNRs as low as -45 dB. Other aspects such as scan-position dependent variation, deep-space noise calibration and the stability of transmit calibration power will also be touched upon.