

SAC Annual Report 2014 - 2015

अंतरिक्ष उपयोग केंद्र

Space Applications Centre

Indian Space Research Organisation, Ahmedabad-380 015.



Director's Preface

SAC/ISRO community is performing its part by delivering the state of the art space systems in particular Payload systems and by developing various space applications. To meet the growing demands of Communication of the country SAC has put commendable efforts to deliver communication payloads with short turnaround time. On January 12, 2015, SAC has delivered a communication payload for GSAT-15 satellite. This will augment the existing INSAT capacity with 24 Ku Band and 2 Ku band Beacon. In the month of November SAC has completed the test and evaluation of the fully integrated GSAT-9 payload consists of 12 Ku band transponders and a beacon. In addition to this, various payload development works are going on for GSAT 7A, GSAT-11, GSAT-17, GSAT-18 and GSAT-19E. SAC is also developing an advanced payload for GSAT 20 satellite for mobile communication.

The need for positioning based services has tremendously increased for civilian as well as strategic usage. In order to meet this high demand, Indian navigation satellite system - IRNSS - is getting established to provide highly accurate positioning with fast update rate for land/sea/air based users. During the year IRNSS-1B, IRNSS-1C and IRNSS-1D satellites were launched and IOT of satellites was successfully completed. Payload for IRNSS-1E was delivered on February 5, 2015. To complete the constellation in a short period, SAC has also geared up with Indian industries. It is envisaged that majority of the subsystems of Navigation payloads will be fabricated and tested at Industry for upcoming navigation satellites. GSAT-15 payload is also carrying GAGAN payload which consists of first time in house developed L Band 40W SSPA. During this period development of Indigenous Atomic Clock Monitoring Unit (ACMU) is also an important milestone. SAC is taking strides in the developments of receiver systems which can support our own IRNSS as well as other global navigation system. 34 Ch IRNSS/GPS receiver was developed with Sophisticated State of Art Signal Processing and Performance is at par. 7 channel L5 & S band IRNSS Signal simulator has been developed and tested with in-house IRNSS Receiver with an average RSS error 0.5 m which is at par with state of the art commercially available simulators.

SAC is playing a very important role in the Remote Sensing, Meteorology, Scientific and planetary programmes of ISRO. Payload development for Resourcesat-2A, INSAT-3DR and Chandrayan-2 is in an advanced stage. Developments related to Cartosat-2C, GISAT, ASTROSAT and a solar observation satellite, ADITYA-1, are under progress.

In the Microwave remote sensing field RISAT 1A subsystem development work is going well many further developments are expected in the coming year. Development for SCATSAT-1 payload is also in full swing. During this year organization of NISAR workshop was also very unique initiative.

In the area of remote sensing applications, SAC has made pioneering contributions in the field of agriculture, forestry, coastal zone management, fisheries, urban planning, watershed development, ground water prospecting, snow & glacier studies, oceanography and atmospheric studies.

Preparation of snow cover maps for 30 basins and Mass balance estimation of glaciers for 2013 for 10 basins were completed. During this period All India three hourly weather forecast at locations having population greater than 50,000 has been released on MOSDAC. SAR data analysis for the Gangotri and Chhota Shigri glaciers was also completed.

I am happy to inform that on initiative of Honorable Prime Minister, for maximizing the usage of Space Technology and Tools in various ministries of Government of India, SAC is playing a lead role in entire activity. Colleagues of SAC & DECU are members of 18 task teams constituted to formulate the plan of action. I am sure this initiative will enhance the importance of the activities carried out at this centre. Currently, More than 150 Technology development projects are going-on at SAC and more than 40 RESPOND program are going on with academia.

SAC has also taken some unique initiatives like "Zero Defect Program", "UMANG: IITPian Meet" and "Green Transportation". SAC is actively participating and contributing in the "Vigilance Awareness Week", "Safety Week", Blood Donation camps.

Administration and Accounts have aptly supported the technical activities and they are playing important role in the Centre's overall activities.

It is also to be noted that SAC communication team had extensively supported the disaster management activities at Jammu & Kashmir. DECU had also established a SATCOM link between Telemedicine terminal at DECU and the patient node at SKIIMS (Shere Kashmir Institute of Medical Science), Srinagar to support the disaster relief activities during J&K floods.

Tapan Misra

SAC Management Council (SMC)

As on March 31, 2015

Shri. Tapan Misra, Director, SAC & Chairman, SMC

Shri. Vikram N. Desai, Director, DECU

Smt. Mallika Mahajan, Controller, SAC

Shri.D. K. Das, DD, SNPA

Dr. P. K. Pal, DD, EPSA

Shri. R. Ramachandran, DD, SIPA

Shri. Saji A Kuriakose, DD, SEDA

Shri. Nilesh Desai, DD, MRSA

Shri. R. K. Arora, DD, ESSA

Shri. R. M.Parmar, DD, SRA

Shri. A. M. Jha, DD, MESA

Shri. K. S. Parikh, DD, SNAA

Shri Vikas Patel, GH, PPG & Member Secretary, SMC



Shri Tapan Misra, took over as Director, SAC on February 17, 2015

SAC ORGANIZATION

As on March 31, 2015

Tapan Misra
Director

Mallika Mahajan
Controller

R Ramachandran
Deputy Director, SIPA

N M Desai
Deputy Director, MRSA

R. M. Parmar
Deputy Director, SRA

Vikas Patel
Group Head, PPG

Saji Kuriakose
Deputy Director, SEDA

D. K. Das
Deputy Director, SNPA

K. S. Parikh
Deputy Director, SNAA

R. K. Arora
Deputy Director, ESSA

Rajeev Jyoti
Group Director, ASG

Dr. P K Pal
Deputy Director, EPSA

Sivanandan G
Internal Financial Adviser

A M Jha
Deputy Director, MESA

Rachna Patnaik
Head Library and
Documentation Division



Independence day celebrations at SAC

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Flagg-off function of GSAT 15 payloads

SPACE APPLICATIONS CENTRE

SAC

The Centre has its origin in the establishment of the Experimental Satellite Communication Earth Station (ESCES), in 1966 by late Dr Vikram Sarabhai in Ahmedabad. Different units carrying out early experiments in communication, remote sensing and meteorology were amalgamated to form the Space Applications Centre in 1972 with Prof Yash Pal, the eminent scientist as its first Director. Present strength of SAC is about 1900 comprising about 1450 scientific and technical and 450 administrative personnel.

At Present, SAC focuses on the design of space-borne instruments for ISRO missions and development and operationalisation of applications of space technology for national development. The applications cover communication, broadcasting, navigation, disaster monitoring, meteorology, oceanography, environment monitoring and natural resource survey. SAC designs and develops all the transponders for the INSAT and GSAT series of communication satellites and the optical and microwave sensors for IRS series of remote sensing satellites. Further, SAC develops the ground transmit/receive systems (earth stations/ground terminals) and data/image processing systems. Technology development programme in the field of satellite communication & earth observation, are also carrying out in the Centre.

Organization Structures of SAC and its facilities

Activities at SAC are organized into following Areas;

- SATCOM and Navigation Payload Area (SNPA)
- Sensor Development Area (SEDA)
- Microwave Remote Sensors Area (MRSA)
- Antenna Systems Group (ASG)
- Signal and Image Processing Area (SIPA)
- SATCOM and Navigation Applications Area (SNAA)
- Earth, Ocean, Atmosphere, Planetary Sciences and Applications Area (EPSA)
- Mechanical Engineering Systems Area (MESA)
- Electronic Support Service Area (ESSA)
- Systems Reliability Area (SRA)
- Planning and Projects Group (PPG)
- Construction & Maintenance Division (CMD)
- Library
- Administration



SATCOM & SATNAV

Payload Developments & Applications

SAC is responsible for designing the communication payloads, developing subsystems and Integrating & testing the payloads for GEOSAT & IRNSS programs.

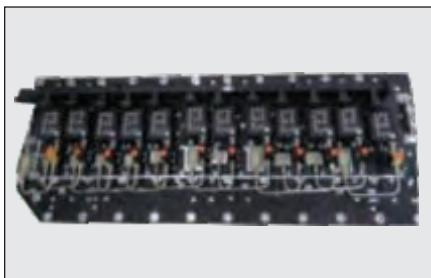
During the year the in Orbit Testing (IOT) and commissioning of communication payloads for GSAT-16 and IRNSS-1C are successfully completed. Payloads for GSAT-15 and IRNSS-1E were delivered to their projects in 2014-15, followed by IRNSS-1D which was delivered in July 2014. Design, development and realization of GSAT-9 payload were completed and ready to deliver.

Development of various Subsystems for GSAT-11, GSAT-17, GSAT-18, GSAT-7A & GISAT are in progress.

GSAT-16

GSAT-16 was launched into a Geosynchronous Transfer Orbit (GTO) by Ariane-5 VA-221 launch vehicle from Kourou, French Guiana on December 7, 2014. GSAT-16 has 24 Nor. C band, 12 Upper Ext. C band and 12 Ku-Band Transponders covering Indian mainland & Island. It also carries a Ku-band beacon to help accurately point ground antennas towards the satellite. It has a mission life of 12 years.

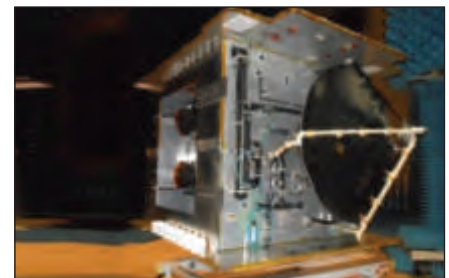
In orbit testing of all transponders was successfully completed and Payload performance was found to be satisfactory. Phase-2 of IOT was completed from AES, SAC and payload performance was found to be normal.



12 channel C-nor DR OMUX



Ku band HMIC based ALC CAMP



GSAT-16 payloads in CATF

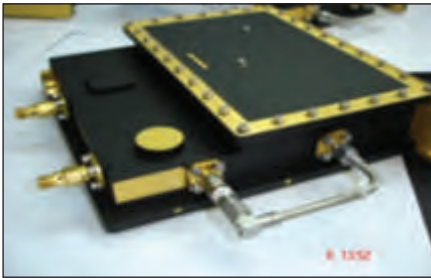
GSAT-15

GSAT-15 Payload consists of 24 high power Ku-band transponders, 2 GAGAN transponders and two beacon transmitters.

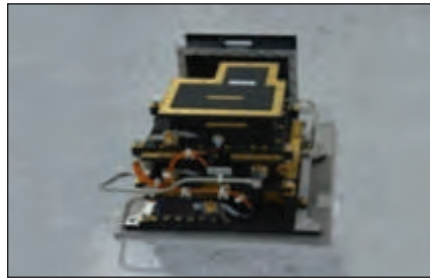
T&E of all the Passive Subsystems were completed. Integrated payload T&E for Ku band, GAGAN payloads and Ku Beacon transmitters were completed successfully. Radiation tests was carried out at SAC. Payload was flagged off from CSL, SAC to ISITE Bangalore on January 12, 2015.

4x4 Helix Array Antenna at L1 & L5 bands with improved Gain & Axial Ratio is realized and delivered to project for integration with GSAT-15 spacecraft. Test & evaluation is successfully completed including high power testing. EM modeling & RF analysis of Helix Array Antenna with EV-mockup is completed. Square Coaxial feed network with sequential rotation technique is implemented in this array antenna for low RF beam forming loss and optimum axial ratio performance. C-band 0.7m antenna was realized and XPI > 28dB was achieved.

120 Watts EPC for 40 W SSPA 1QM and 2 FM were designed based on resonant reset forward converter topology with phase shifted full bridge converter based has been realised and delivered to the project. EPC for L1/ L5 Up converter in GAGAN payload (4FM) has been designed and delivered to the project



100 MHz LO



Up-converter



40-Watt L-Band SSPA

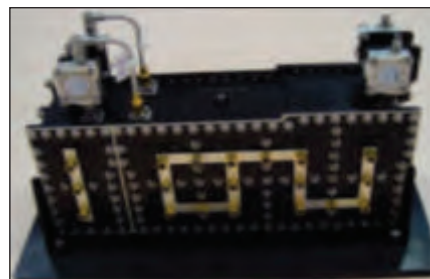
GSAT-6

GSAT-6 is a geostationary satellite, operating from a geo slot of 83deg E aimed to provide multimedia mobile services. The spacecraft is configured to provide SXC and CXS transponders.

All antennas are delivered and integrated with spacecraft. Assembled mode IST, EMI/EMC and Spacecraft level thermo-vacuum tests were completed at ISITE, Bangalore and Payload performance was found to be normal.



S-Band Output Filter



S-band narrow band filters with external GD equalizer

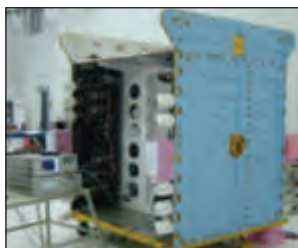


GSAT-9

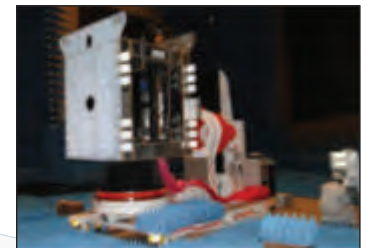
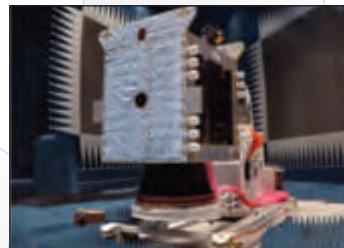
GSAT-9 has 12 Ku-band channels to augment Ku-band services for DTH with India mainland and Andaman & Nicobar coverage. It also has a Ku beacon transmitter for Indian mainland and Andaman & Nicobar with 480E location.

All subsystem development is completed. including EPC for AKON DA (12 FM) and delivered to the project. Payload was successfully integrated and tested in SAC-CATF.

T&E of Ku-band India coverage shaped reflector antenna (Rx band) was successfully carried out. Optimization was required to compensate for the surface profile distortion effects.



Integrated Ku-Band Payload on Tri-Panel



GSAT-9 Payload under Test in CATF

GSAT-11

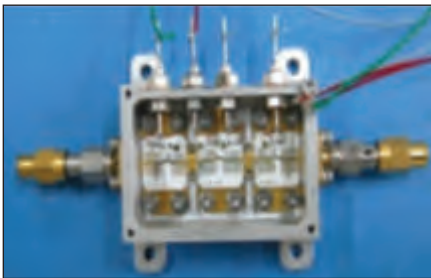
GSAT-11 has Ka X Ku band multi beam payload with 32 Ku band user spot beams and 8 Ka band hub beams. It is a high through put satellite based on I-4 K bus. Payload mass is about 597 Kg and mission life is 12 to 15 years.

Subsystem development is under completion. For GSAT-11, 17 QMs & <300 FM passive subsystems were developed. T&E of Upper Ku-band IMUX (8 FM), Ku-Band PIM Filter (QM + 32 FM), Ku-Band Tx-Rx Coupler (QM+32 FM), Ka-Band PIM Filter (QM + 08 FM), Ku-Band Output hybrid network (QM+1FM), Ku-Band HRF (QM) & Ka-Band HRFs (QM + 10 FM) were completed. Open loop test of simulated tracking payload chain was completed successfully at SAC CATF. Nearly all FM filter assemblies are available. All panel layouts are finalized.

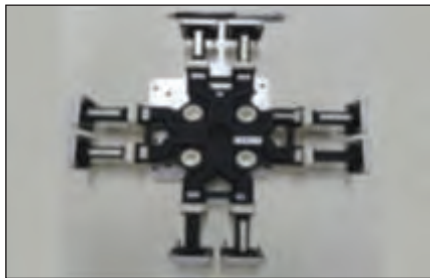
Design of PIN diode base SP4T switch is completed and DVM unit has been developed. The in-house designed SP4T switch will replace the imported SP4T switch. The package of SP4T switch along with its control circuitry, power dividers and power combiners is designed.

GSAT-11 multibeam satellite antennas crossed one major milestones of development of communication cum tracking feed with measured performance is in close agreement with predicted performance. Successfully developed qualification model of SE feed Cluster assembly of Ku-band multiple beam antenna. T&E of SE reflector antenna was carried out successfully and measured beam to beam isolation was in close agreement with the predicted one. QM of Ka-band feed elements undergone through RF measurement tests. Ka-Feed cluster readied for T&E. A study was carried out to optimize the ground station requirement for conducting IOT of multiple beams. Ka-band Tx/Rx diplexers (18 nos. including 1 QM, 8 FM and 8 nos. for payload check out) realized and initiated the assembly. Ku-OMT has successfully gone through EMI/EMC and multipaction test.

High power TWTA for Ku band and Ka band procurement activity completed and received the both TWTA. Low voltage EPCs for all RF sub-systems procurement activity is in progress. Six types of EPCs development are ongoing. Breadboard units were electrically verified.



Power stage of 2 W Ku-band Beacon SSPA



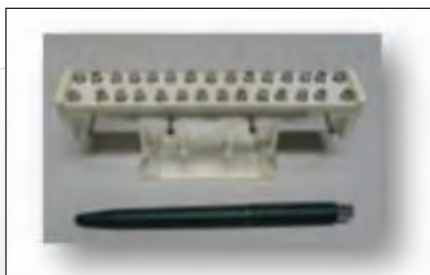
Ku-band Output Hybrid Network



DVM Unit of Ka x Ku Converter



Antenna closed loop tracking test



Ka Band Output Filter

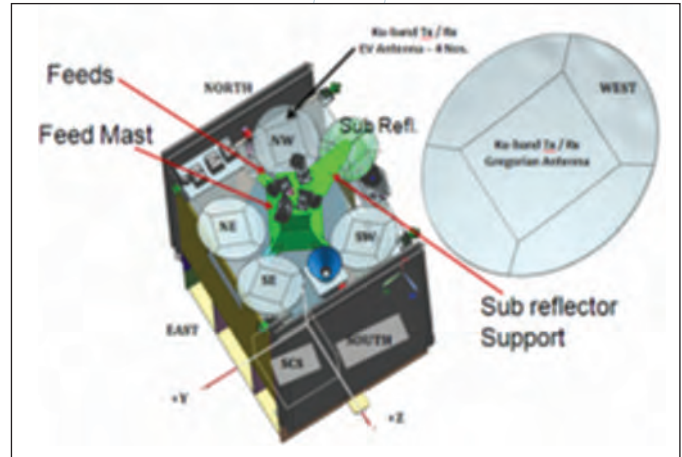


Ku band output hybrid n/w for multiport amplifier

GSAT-7A

GSAT-7A payload has switchable frequency plan for mobile users in Ku-band. It has one Gregorian antenna and 4 numbers of steerable reflector antennas.

Payload related details were documented and presented in Incremental CDR. Preliminary payload configuration was worked out and submitted to GEOSAT-PMO, ISAC. All panel layouts were finalized. All electrical and mechanical design was completed and loaded for fabrication.



RF design of Gregorian shaped reflector antenna was carried out to enhance the gain roll-off beyond the coverage. Exhaustive scattering analysis is carried out using hybrid methods like MoM+FEM and PO+MoM for accounting various scattering effects of spacecraft elements and surrounding reflectors. RF Design of steerable shaped reflectors is carried out to improve the cross polarization isolation and roll-off. Feeds and moulds are under development.

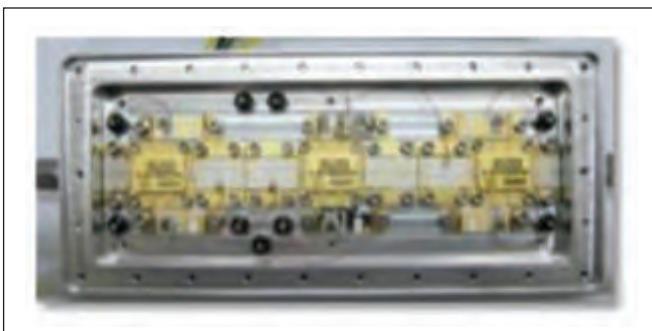
GSAT-17

GSAT-17 communication payload consists of 24 Nor. C-band Transponders, 12 Ext. C-band Transponders, Lower Ext. C band Transponders and 1 DRT/SAR Transponder. It has 2 MSS forward & return link Transponders with Digital flexible bandwidth Processor.

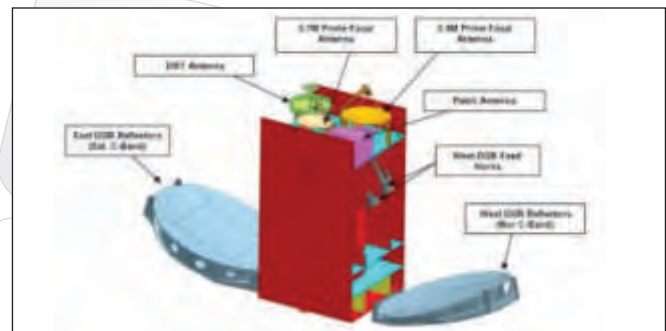
Subsystem development is under progress. Indigenous 32W Upper Ext-C Band SSPA design is finalized. DVM of Nor C Band 2 CH DR OMUX (2 MHz) was completed. Testing of Helical filters at 332 MHz, 469 MHz & 554 MHz for DRT/SAR payload is completed. Revised payload configuration for DRT and SAS&R transponder and MSS transponders based on digital and SAW filter configuration is finalized.

New development of new DRT/SAS&R Receiver has been completed. As compared to the heritage INSAT-3D design, the centre frequency, bandwidth and frequency stability requirements of DRT/SAS&R receiver have changed in GSAT-17. The new receiver design has resulted in the reduction of weight and volume by 40% as compared to heritage.

Design and Analysis of 0.7 m [Tx-Rx] Prime focus Reflector Antenna and feed for Nor-C-Band Tx- Rx West DGR was completed. Analysis and optimization of Patch array antenna (Tx/Rx) for horizontal polarization and optimization for vertical polarization was completed. Design of Tx/Rx radial corrugated Horn feed of Nor C-Band & Upper Ext-C band DGR was completed. EPC for the 32W Upper Ext-C Band SSPA design has been finalized and development is in progress. EPCs for DRT/SAR subsystems are under final stage of completion.



C Band MMIC-based CAMP



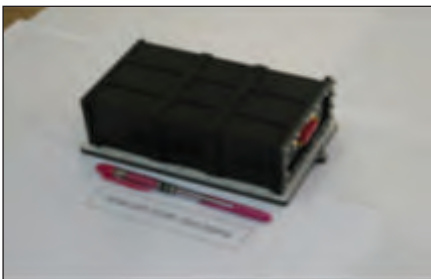
GSAT-18

GSAT-18 is a geostationary satellite, operating from a geo slot of 74deg E. It has 24 Nor-C band transponders, 12 upper Ext-C band transponders, 12 high power Ku band FSS transponders and 2 Ku-band beacon transmitters.

Subsystem development is in progress. North & South panel layouts generation is completed. Payload CDR was completed. Testing of channel filters of 6-channel upper ext. C-Band DR OMUX was completed. T&E of upper Ext. C-band 6-Ch DR OMUX (FM-1) is completed. Ku-Band TCKO Omux is the first ever successful development and Realization of Temperature compensation technology.

50 Watts EPC for 15 W SSPA 12 FM units were designed based on current mode push pull converter topology. This is incorporated in the indigenous SSPA which is a replacement for Melco Make units. Units are developed and are at the final stage of completion.

A novel design for 1.4m Shaped Prime Focus Reflector antenna (C-Rx bands) based on near-field minimization is carried out to achieve high Cross-polarization Isolation ($> 30\text{dB}$) over NorC & ExtC Receive bands by minimizing the deteriorating impact of Feed-strut & Reflector-Feed interactions. A metallic DVM of the antenna has been realized. A compact Offset Shaped EV-top antenna with low F/D ($=0.83$) has also been designed as an alternative to the Shaped Prime Focus antenna to achieve high cross-polarization while avoiding undesirable scattering sources within the radiating aperture. Rigorous RF analyses are done to finalize the design of Feed-mast and EV-deck layout.



50W EPC for 15 Watts C-Band SSPA



15-Watt C Band SSPA - QM

GSAT-19

Payloads for GSAT-19 were configured with Ka, Q, V bands and optical transponders. It provides a platform for advanced technology experiments. Hybrid RF-Optical link is configured to get enhance availability and would provide high data rate of 100 Mbps (with RF-optical links) / 1 Gbps (with Optical-Optical links)

As a part of optical Terminals Development, Thermo vacuum test of optical receiver has been carried out and the performance found to be satisfactory. Detailed block diagram comprising of optical communication module along with ATP and optics has been prepared.

GSAT-20

GSAT-20 is an advanced multi-beam Geo-mobile satellite to provide services to hand-held type terminals over Indian region. Specifications for Digital processor were worked out considering the MSS requirements.

IRNSS

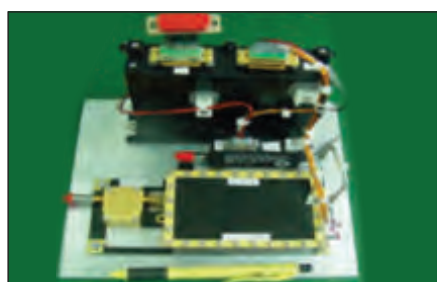
Indian Regional Navigation Satellite (IRNSS) will comprise of a constellation of seven GPS navigation satellites. IRNSS payload consists of L-band & S-band navigation payloads and CxC ranging transponders.

During the year IRNSS-1C & IRNSS-1D were launched from SDSC SHAR, Sriharikota on October 16, 2014 & March 28, 2015 respectively. In-orbit tests (IOT) was completed and Payload performance was found to be normal.

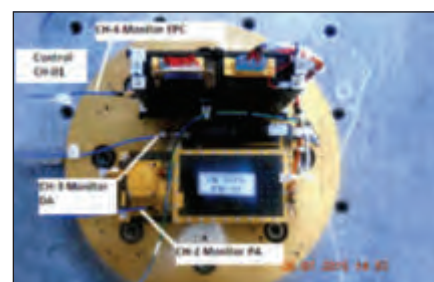
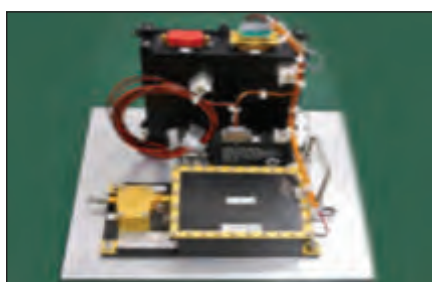
All subsystem development of IRNSS-1E was completed. Payload level thermo-vacuum tests and radiation mode tests for navigation and ranging payload was completed at SAC and results are found to be satisfactory. After T&E payload was flagged off from SAC to ISITE Bangalore on February 5, 2015.

All the three antennas (1. Shared Aperture helical Array Antenna, 2. C-Tx dual mode horn, 3. C-Rx Dual mode horns) are realized, characterized and delivered for IRNSS-1D, 1E projects. Antennas are successfully flown on IRNSS-1D, in-orbit radiation patterns matches well with ground reference. RF analysis of Helix array antenna is carried out in presence of spacecraft, and Spacecraft on CATF Positioner to assess the impact of these scatterers. Their impact is found to be insignificant. Phase center methodology is established for sub-system, antenna integrated with payload on spacecraft. Measurement of phase center variation is attempted & successfully completed for the first time on antenna integrated with payload during IRNSS-1D, ISAC, CATF.

Presently, subsystem development of IRNSS-1F payload is in progress. Payload is expected to be delivered on August 2015.



IRNSS-1E: 5-W C-band SSPAs (FM-1 & FM-2) for Ranging payload



5-Watt SSPA T&E at AMPL



TVAC Test of IRNSS-1E Payload



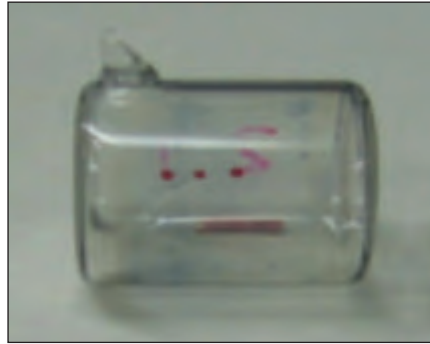
IRNSS 1E: Delay Measurement of Helix Array Antenna

DEVELOPMENT OF INDIGENOUS RB CLOCK

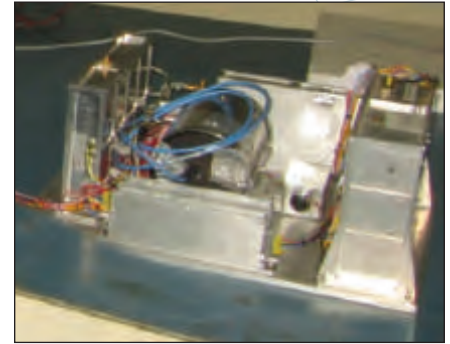
With the view of having indigenous atomic clocks onboard second generation IRNSS satellites, rubidium clocks are being developed at SAC. Presently, we have cells and lamps fabricated on a collaborative project from National Physical Laboratory (NPL), Delhi. Physics Package and related electronics, temperature control units, microwave synthesizers, lamp oscillator circuits are being developed at SAC. Recently, an ETM model of one such unit has already been demonstrated showing the Allan deviation stability of $2.5 \times 10^{-11} \sigma^{-1/2}$ at 1s.



SAC lamp Oscillator with NPL Bulb



NPL made Rb. Cell



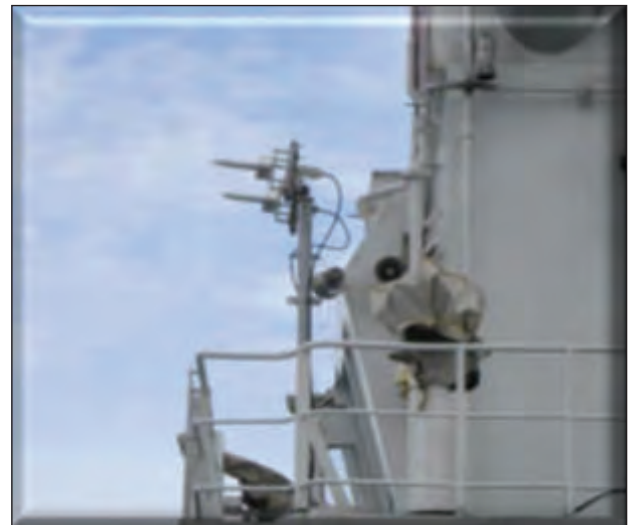
Indigenous Rb Atomic Clock thermal model

The required stability specification for IRNSS is one order of magnitude better than presently demonstrated above value, i.e., $< 5 \times 10^{-12} - 1/2$ at 1s and the clock performance should reach the level of $< 5 \times 10^{-14}$ at 10,000 s. Currently, the developments are in progress to find novel ways to improve the clock performance. Furthermore, to qualify the clock for space operation.

CARE MISSION

System simulation & analysis to meet the telemetry (TM) communication requirements for the reception of TM signals at SHAR & Port Blair ground stations and ship based terminal is carried out. Measured in-flight communication link parameters analyzed and it matched closely with the simulated data.

LHCP, RHCP Microstrip patch Array Antennas on crew module and Ship borne terminal helix Antennas are functioned flawlessly during the CARE mission. Data is received from these antennas during all the phases of mission. RF design, realization and characterization with crew module mockup are completed within a span of three months.



Ship borne Terminal Antenna

OPTICAL COMMUNICATIONS DEVELOPMENT

Optical transmitters and receivers up to 1GBPS have been developed and characterized. After successful demonstration in lab and Building to building these units have been tested for temperature including thermo vacuum test on one unit each.



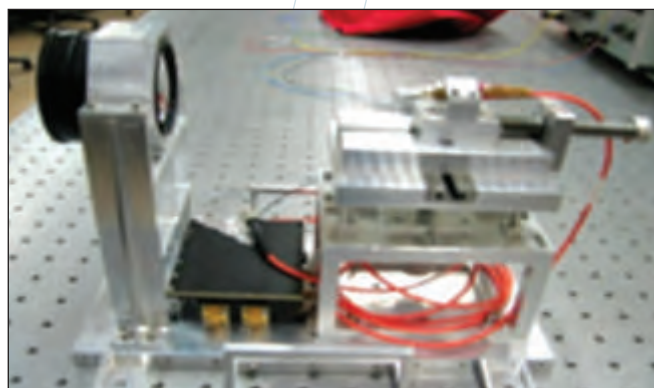
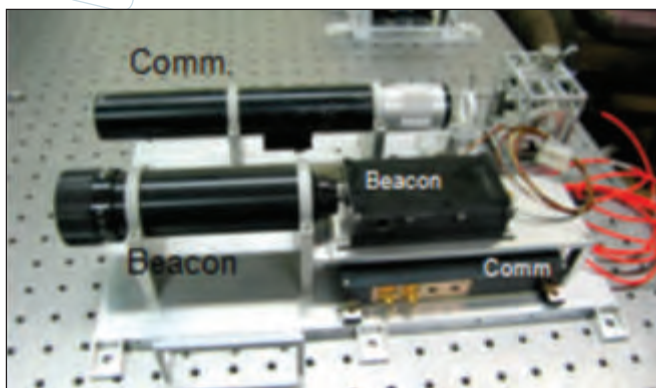
PI send high Resolution Image

Optical Transmitter and receiver

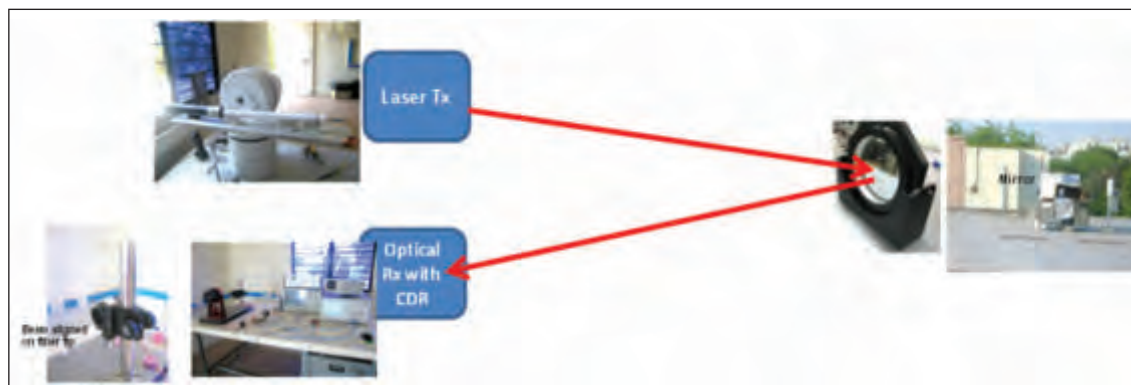


Thermo vacuum test setup

2. Building to building link of 1Gbps established with in house developed modules.



Tx & Rx end assemblies



Range enhancement using reflector for 30 meter characterizations

Development of optical communication terminal proposed for GEO payloads, for GEO to Ground link has been taken up. The required active/passive components for the communication modules are under procurement.

Other SATCOM/SATNAV Projects /Applications

GSAT-6: Terminal development

Reporting Terminal : Testing of Reporting Terminal and all its user interfaces with HUB receive system was completed. Functionality of Reporting Terminal was demonstrated through satellite using high gain antenna with all its user interfaces (Keypad, UART, USB) by receiving data at HUB through INSAT-3C satellite. Environmental Tests for Reporting Terminal was completed. Development of firmware, porting, testing and field trial for automatic detection of predefined railway crossing and alarm generation based on live geo-location using reporting terminal was carried out. GSAT-6 reporting terminal antennas (Qty- 20 nos.) are developed and delivered to the project. The antenna is compact size patch antenna including a radome. Under this activity, alternate design option of the antenna using dielectric resonator is pursued. Different designs are carried out to achieve the RF performance using high dielectric constant material ($\Delta r=20.9$ developed through VSSC). Developmental efforts are also put to design and realize broadband dielectric resonator antenna (DRA) for satellite mobile radio applications.

Broadcast Receiver Terminal: Proto unit of S- Band broadcast receiver was demonstrated through GSAT-12. Fabrication & testing of Two RF frontend modules was carried out and test report along with complete design details were sent to ANURAG (Advanced Numerical Research Analysis Group, DRDO). Assembly

of newly designed RF frontend PCB with programmable synthesizer and mixer was completed. Android based host application software development was completed and tested successfully. Antennas for broadcast receiver (25nos.) were developed and delivered to the project.

Satellite Mobile Radio Terminal: Development of tool-chain of Satellite Mobile Radio Terminal was established with available Keil Setup and JTAG. Testing of 2.7 kbps QPSK burst L band demodulator using RT firmware was completed. Developed the firmware and ported on MSP 430 baseband hardware for synchronous to asynchronous converter with unique word detection feature to support PC based VGU.

Portable Multimedia Terminal: Implementation & Testing of FPGA modem with signal strength indication was completed. Testing of PMT with multimedia hub and terminal baseband software was completed successfully.

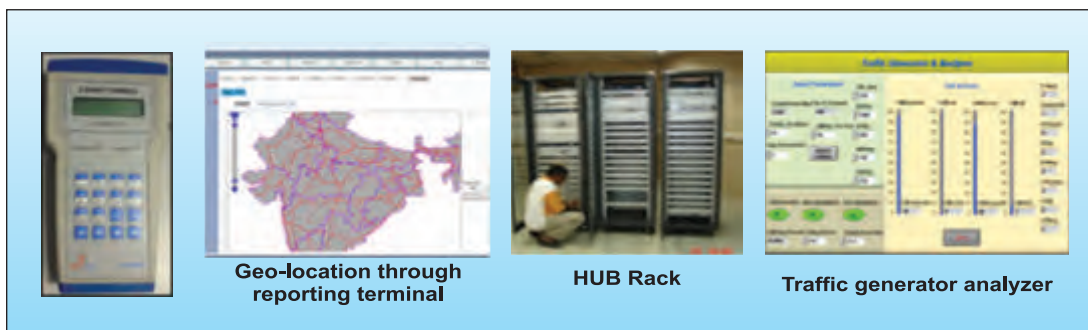
GSAT-6: HUB Base band systems Development

SAC has developed Multi-beam IP based HUB for Reporting, Voice, Multimedia and Broadcast services.

Reporting services: Fabrication of cables and cable harnessing for reporting services and multimedia services were completed. Reporting service was integrated successfully with reporting terminal. Reporting service and broadcast service using satellite INSAT-4C were demonstrated to the Director, SAC. T&E for the Reporting Service HUB Baseband System Software for GSAT-6 Mobile Satellite Service (MSS)-was carried out. T&E of Reporting service Hub baseband system were completed and released final T&E report.

Broadcast service: Broadcast service was integrated with broadcast terminal. Integration of Broadcast service with total Hub baseband system and with terminal is in progress.

Multimedia service: T&E of multimedia service Hub baseband system of GSAT-6 Application project is in progress. Integrated testing of multimedia services Hub baseband system in IF loop back with simulated terminal was completed. Integrated testing of multimedia services Hub base band system in RF loop back with simulated terminal and actual terminal, developed by industry, is in progress.



Reporting Service

GSAT-11 Tracking Receiver

SCRC has approved the design of tracking receiver. Testing of integrated software on Interface Card using MIL-1553 Tester simulator was carried out. Fabrication sequence document for QM & FM units & In-Orbit Testing (IOT) document was prepared.

IRNSS: User Receiver & Ground Segment

7 channel L5 & S band IRNSS Signal simulator has been developed and tested with in-house IRNSS Receiver with an average RSS error ≈ 0.5 m which is at par with state of the art commercially available simulators. In-

house simulator has been made capable to generate ionospheric & troposphere effects and tested successfully with in-house receiver for long hours. The first phase of long code verification has been completed. The automated software for 8-week code generator has been used to generate code generation parameters for various Z-counts and these parameters have been provided to NSGU. The development of second version of key generation software according to FIPS guidelines is in progress. Software to select different encryption algorithms for different satellites with different key sizes (128/192/256 bits) has been developed and delivered to ISAC.

34 channel SPS Receiver complete design, with correlators and Navigation processor, is ported on Zynq board. Extensive testing and characterization is initiated. Two SBAS channels were also added to make it 36 channel IRNSS SP_GPS_SBAS receiver. This supports three simultaneous modes of PVT solutions. NMEA interface (commands + logging) and "warm start" integrated with receiver. Validation of Navigation frames for IRNSS-1C was successfully done during IOT using Payload Test Receiver.

4 channels RS receiver for simultaneous monitoring of IRNSS-1A and IRNSS-1B at MCF/SNG has been tested with simulator and is currently used for monitoring IRNSS-1A live signals. Development of 14 channel RS receiver with tracking error performance of < 35 cm. 2 D position error was achieved with 3 IRNSS satellite and in-house developed SPS and RS Receivers. Twenty IRNSS SPS_GPS Receivers were delivered and same were distributed among Six Academic Institutes and ISRO centres for field trials. Three field trials of IRNSS SPS user receiver were conducted outside SAC with receiver mounted in WLL-VSAT Van. The data was logged, analysed and documented. Improvement in position availability was observed in Hybrid mode compared to GPS only mode or IRNSS-2D mode. As a part of IRNSS Baseband ASIC development activity, The 34 channel code with 2046 taps massive correlator is successfully synthesised at SCL and first cut resource requirements is estimated. IRNSS SPS Rx in Bulk quantity is being realized partly based on turn key basis and partly based on SAC design and integration by industry. ATP and 168 hours burn-in test of Data Acquisition & Recording System for IRNSS Signal Monitoring Facility was completed.

IRNSS SIGNAL MONITORING SYSTEM (@ AES)



6.3 M Antenna System



Data Recording & Analysis System



IRNSS Simulator (In-house Developed)



36 Channel IRNSS User Receiver

Remote Sensing (Optics & MW) Payload Developments & Applications

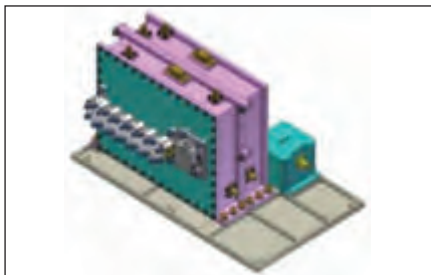
SAC is responsible for the design, development and realization of optical remote sensing payloads for Earth observations, Meteorological applications, planetary missions and airborne applications. Currently SAC is involved in developing payloads for nine missions for low earth orbit (LEO), geostationary orbit (GEO) and a lunar mission. These include cartosat-2C/2D, Cartosat-3/3A/3B, Oceansat-3, Resourcesat-2A, INSAT-3DR&S, High resolution GEO (GISAT), Chandrayan-2 and Aditya-1

INSAT-3DR&S

INSAT-3DR is a follow on satellite of INSAT-3D. It has 2 payloads; Imager & Sounder and DRT/SAR receiver. Subsystem development is under completion. Payloads are expected to be delivered soon.

As compared to the heritage INSAT-3D design, the centre frequency, bandwidth and frequency stability requirements of DRT/SAS&R receiver have changed in INSAT-3DR. The new receiver design has resulted in the reduction of weight and volume by 40% as compared to heritage. New development of new DRT/SAS&R Receiver has been completed.

INSAT-3DR communication payload consists of Met Tx, DRT Transponder & SAR Transponder. Development of Imager modulator, Sounder modulator, LO & Integrated testing of the modulators with U/C & EPC was completed. Met Tx package is ready for T & E. Development of FM units of PSF, OMUX and DVM of SAW & Digital filters for DRT & SAR Rx were completed.



DRT/SAS&R Receiver



Digital filter

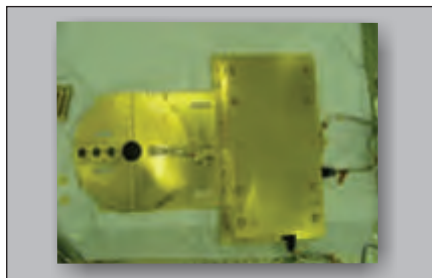
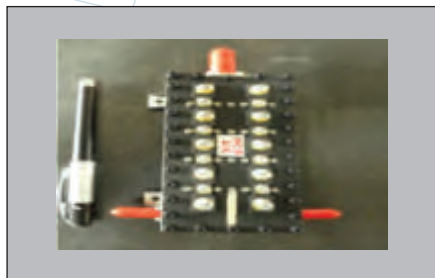


MET TX - FM

All phases of T&E of Imager payload are completed. Spectral Response and Radiometric calibration of Imager (Vis and SWIR) channel was carried out in the clean room as a part of FBT. PSR was held on December 29, 2014 and document was prepared.

Thermovac test on Sounder (calibration cycle) has been completed in 5.5m thermovac system. Detailed Pre T&E Electrical measurements for Sounder payload was completed. T&E document for payload was generated. Phase-1 T&E of payload was started. Initial bench test on optical parameters viz. IFOV, MTF, Registration was completed.

Mechanical modeling of the 0.9m Dual-Feed assembly along with mounting interface was completed. The secondary analysis of compact Dual feed horn [130 mm] of 0.9 m C band Antenna and 3D mechanical modeling of UHF antenna was completed.



INSAT 3DS, the ground spare is a follow on of INSAT-3DR. Subsystem development is under progress. Camera electronics, NIR-20 FM package assembly and functional testing of Imager payload were completed. NSR-20 FM package assembly of sounder payload was completed.



INSAT-3DS Imager and Sounder Packages

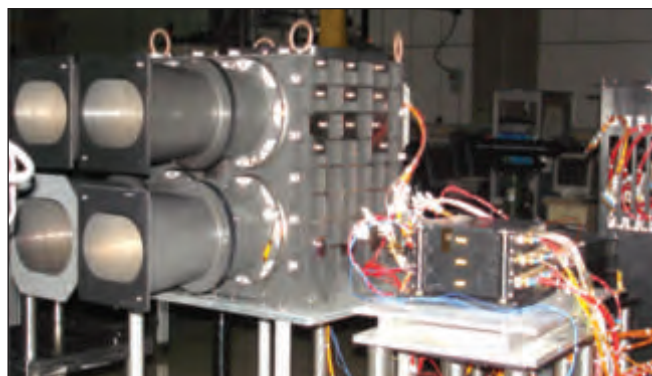
RESOURCESAT-2A

RESOURCESAT-2A is a follow on of Resorcesat-2. It has 4 payloads; LISS-3, LISS-4 and AWIFS- A&B.

Optics, camera electronics and mechanical system development of resourecsat-2A payloads are in progress. Vacuum verification test for (B2, B3, B5) of LISS_3 payload in 3m thermovac system was completed. T & E results document for LISS-3 (SWIR) Camera Electronics package "PLE-25" was released. Burn-in and T&E of two units of PDAS of LISS_4 payload was completed. T&E of DHU (second unit) of LISS_4 payload was completed. EOM structural parameter measurements of AWiFS A&B was carried out. Thermo-vacuum test of six FM VNIR DHAs (B-2, B-3, and B-4 of AWIFS-A&B) was completed.



LISS-4 Structure



LISS-3 Camera EOM under evaluation*

CARTOSAT-2C

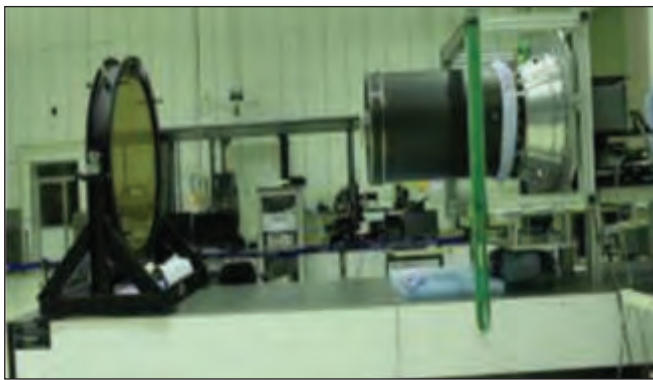
Cartosat 2C, the next payload in the Cartosat 2 series, will provide continuity of data services to the user community on operational basis. It has a spatial resolution of 0.63m PAN and 1.57m MX bands with an operational life of 5 years. Time Delay and Integration (TDI) detector with enhanced radiometric performance will ensure continuous imaging.

Camera electronics and check out system of optical payloads is in progress. Design & development of Checkout Instruments of MX payload was completed. Payload Evaluation Software for MX Optical Butting Test Setup for MATRIX mode of operation established and the interface test with the Camera Electronics hardware was carried out. Functional Testing of PDAS, Data Simulator and Acquisition Software for

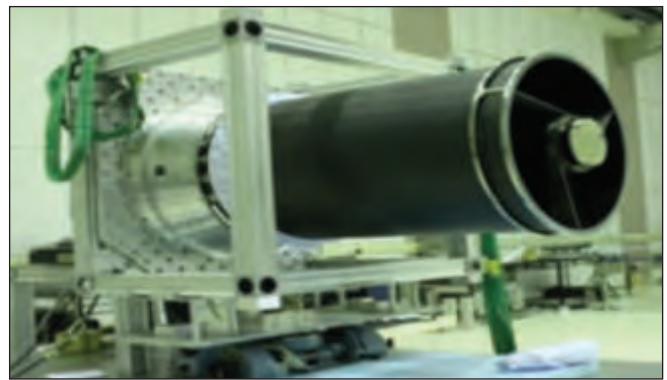
supporting data acquisition in Variable Time Integration (VIT) mode was completed. Final interface test with modified front end electronics (to reduce negative spikes) (3 and 2 sets) of MX detector was completed. Functional testing of PSI-second unit of payload checkout system was completed. Development of commanding and Data Acquisition System for interface testing with Camera electronics was completed. Development and integrated testing of PDAS (1 detector, N & R chain UT54LVDS 217/218 SerDes data interface) with XScope was completed. VM FECE - PPS Interface test for FECE was carried out.

Burn-in Life test of two 8K TDI devices (2000 hrs.) (Total 4) of PAN payload was completed as part of qualification test. FPGA design of the Payload Data Simulator Master Card with 90C124 data interface was completed. Development of Data Acquisition with 90C124 serdes interface and GP-GPU based RT/NRT Data Processing System at 3.4 Gbps data rate for optical butting exercise was completed. First phase of Interface tests of detector with Camera Electronics was completed. Bias & clock measurements on the BBM Camera Electronics Card for operating the detector of PAN payload was carried out.

Detector card fabrication for TDI radiation test of EVM-1 payload was completed. Active burn-in life test (as a part of Qualification) on first & second detector was completed. Development of Data Unpacking software module using GP-GPU for Mode 1 format was carried out. FPGA design & testing of Data Simulator for Mode 2 was completed. Development of Data Acquisition and data unpacking (serial to parallel conversion of 16 data channels, 1 control channel & 1 Aux channel) software modules using GPGPU under CUDA environment at 2.56 Gbps was completed.



Carto 2C payload during testing



Cartosat-2C telescope

CARTOSAT-3

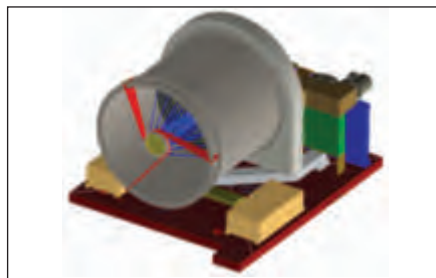
Cartosat-3 is an advanced version of Cartosat-2 series with improved spatial and spectral characteristics (0.25m PAN, 1m Mx, 5m MIR, 5-12m HYSI-VNIR & HYSI-SWIR).

Baseline Design Review for Payload Electronics was carried out. Camera electronics was initiated. Design of FPGA code in VHDL for interfacing with USBFT2232 and DAC121S was carried out. Preliminary components and power requirements was compiled for MX & PAN FECE.

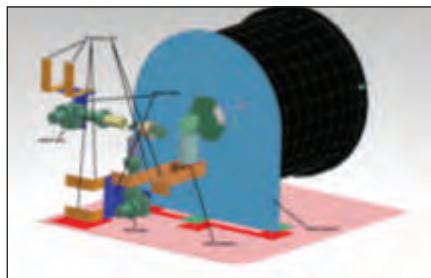
MICROSAT

Microsat is required to be launched and operated on short notice. The payloads consist of a PAN camera (0.5 μm to 0.85 μm) with a resolution of about 0.78m. It will have swath of 3.2km. This camera can be used during sun-lit portion of the orbit. In addition, there are two IR bands: MIR (3.7 μm to 4.8 μm) and LWIR (7.7 μm to 11 μm). The resolution is about 6m. This camera can be used during eclipse portion of the orbit and during day and night to cover the required area. Satellite can provide a step-n-stare factor up to 1:6.19 to improve SNR. Considering piggy-back launch, the satellite may be injected into 500km orbit. Over a period, with natural decay, the orbit will reach to 300Kmx350km. The mission life will be about 6 months to one year.

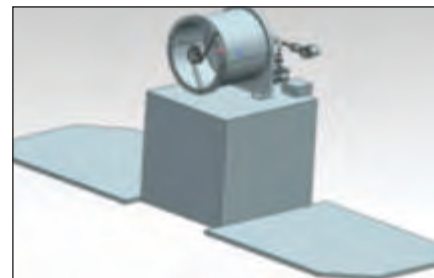
Preliminary Design Review for Payload Electronics was carried out. Camera electronics design is initiated and preliminary components, power/ thermal requirements and interface has been worked out.



Cylinder Based Configuration



Heat Removal Mechanism for IDDCA

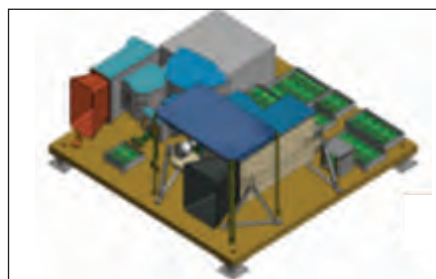


Geometrical Model of Microsat Payload

HYSIS

HYSIS mission will provide global coverage on repetitive basis to users and also supplement the existing multi-spectral missions. The spaceborne hyper spectral imaging spectrometer (HYSIS) will image the earth surface in VNIR (0.4 to 0.9 m) and SWIR (0.85 to 2.4 m) spectral region of the electromagnetic spectrum in 64 contiguous spectral bands in each spectral range with 10 nm bandwidth. It will provide 30 m spatial resolution and a swath of 30 km. The HYSIS payload will be based on standardized IMS-2 bus.

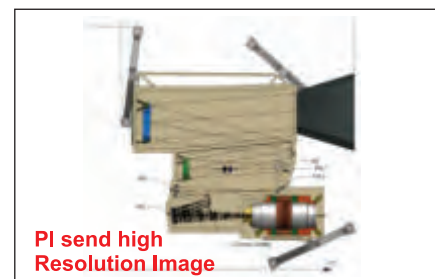
Baseline Design Review for Payload Electronics was carried out. Configuration studies are completed and Interface details worked out. Camera electronics design is initiated.



Optical Schematic



VNIR EOM



SWIR EOM

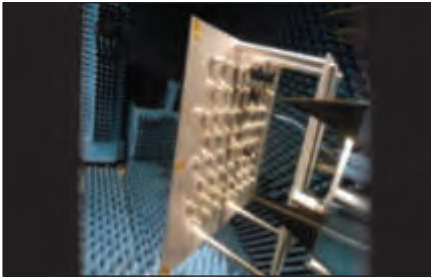
GISAT

GISAT will provide high resolution images on continuous basis from GEO orbit. Payloads will consist of Multi-spectral camera and Hyper spectral cameras. There are number of challenges in terms of spectrometer design, realization and accommodation of all the channels, focal plane test bench development, thermal management etc.

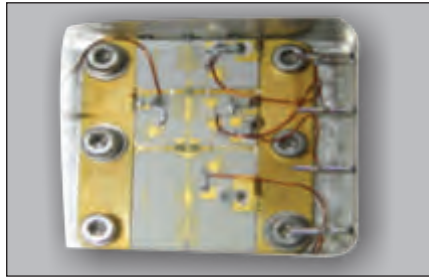
All the subsystems specifications and design of GISAT Data Tx. are finalized and DVM development are in progress. DVM development of Radiating Elements, Band Pass Filter, Hybrid and Test coupler is completed. Realization of DVM optical bench at CMSE completed. Mechanical package design for SSPA Tx. Module is completed. PDR - 2 for Data Tx payload is completed.

Ku-Band 3x3 Patch Array of 8x8 Main Patch Array Antenna (DVM) has been characterized at Anechoic Chamber. Radiation pattern characterization of the antenna after thermal cycling of phased array antenna at Ku-band was completed. Process qualification of RT Duroid 6002 with quartz honeycomb and soldering of Xilinx Virtex 5 FPGA is under progress.

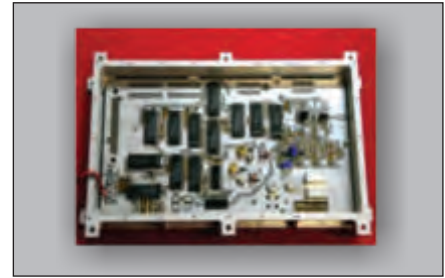
Development of DVM of 200Mbps QPSK Modulator with Rate 7/8 FEC was completed & Integrated testing of the modulator with DVM of Camera Electronics package and Ku band RF subsystems (U/C, Hybrid, BPF etc) was completed. Development of DVM of EPC for modulator is in progress.



Ku Band Patch Array Antenna



Transmit Module using Tri-Quint Power Transistor Dice



200 Mbps Modulator



DVM EM Coupled Patch Array Antenna of GISAT

RISAT-2A

System configuration study with new specifications of TWTA was initiated considering Reflector based Antenna. Stripline coupler design was completed. Reliability analysis for Antenna Control Unit (ACU) as a design option for TCU was completed. System configuration was finalized. TR-LTCC Module level Package work was completed and Hardware is under realization. Payload BDR was held on March 17, 2015.

Nearly square aperture active phased array antenna at X band is planned for RISAT-2A with capability of electronic beam steering in both azimuth and elevation. The array analysis of 3.08m x 3.17m aperture antenna has been carried out for various layouts to optimize the sub-array size and to finalize modularization of the antenna aperture. Parametric study has been carried out to optimize tile and panel gaps with respect to RF performance of the antenna. Dual polarized stacked patch electromagnetically coupled and aperture coupled patch antenna element has been selected and designed to develop 8 x 8 planar sub-array antenna.

RISAT-3 (L-band SAR)

L-Band SAR DVM Integration and Characterization is completed. Design and development of L band LNA using indigenously developed LNA MMICs is completed. Generated L-Band SAR proposal document was generated. Active Antenna characterization for full-polarization configuration is completed.

Mm-Wave Sounder

TSU

Integrated Testing of complete 17 Channel TSU Receiver (with new 23.8GHz and 50-60GHz front-ends) is

completed. 50 MHz TCXO Reference Package is fabricated and tested. The design of feed horn for the new quasi-optical network for TSU antenna at 50-60GHz is completed. The design of feed horn for TSU antenna at 23-31 GHz is completed. Payload testing is being carried out in integrated mode condition.



50 - 55.1GHz V band LPF



55.35 - 60GHz V band HPF

HSU

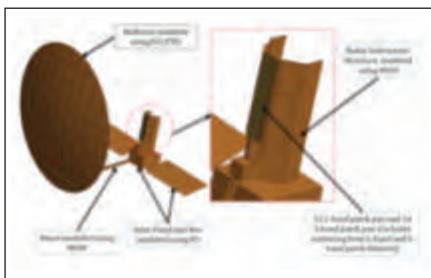
Realization of the corrugated horn and backward wave coupler OMT at 89GHz is carried out. The layout design of RF & Digital EPC is completed. Assembly integration and testing of 3 Nos. of W-Band LNA is completed. Antenna Elements Like Feed horn, OMT, reflectors @23-31GHz, 50-60GHz, 89GHz & 183GHz realized and tested successfully. RF measurement of 50-60GHz Quasi-optical Network completed meeting expected results. Assembly, integration and testing of total 5 Nos. of W-Band LNA was completed. Developmental model of 183GHz smooth wall spline profile Feed Horn has been characterized successfully for first time at CATF.

NI-SAR

Dual frequency Sweep SAR at L and S-bands is being developed jointly with JPL/NASA where the responsibility of SAC/ISRO is to develop the S-band SAR system.

Subsystem development of dual frequency sweep SAR at L & S-band is in progress. SAC has received latest payload mode definition table from JPL. Secondary radiation pattern has been analyzed for SAC modeled reflector antenna using primary feed patterns received from JPL/NASA primary feed. SAC has received accommodation feasibility study package from JPL on September 24, 2014. The design of planar array consisting of 2x4 elements at L band and 3x12 elements at S band has been completed. NISAR Technical Interface Meet (TIM) was held on November 20-21, 2014 between SAC-ISRO and JPL-NASA. Preliminary package design of SynOT was completed.

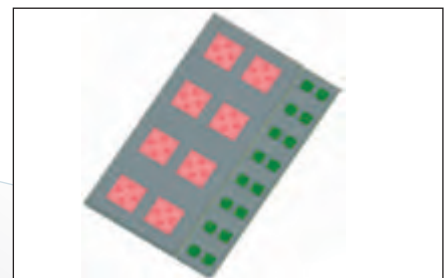
In this year a broadband dual polarized probe fed single layer microstrip antenna having differential inputs (0 and 180 degree phase) for better pattern symmetry and cross polarization suppression is designed and optimized at L and S Band. Standalone primary feed array with 3 x 2 elements at S Band with and without Surface Mounted Horn has been designed, fabricated, integrated and characterized. RF modeling of NISAR antenna has been carried out including reflector boom, feed RF aperture (taking into account of patch reflection/transmission parameters), radar instrument structure (RIS), I3K bus and solar array.



Electromagnetic modeling of NISAR Antenna



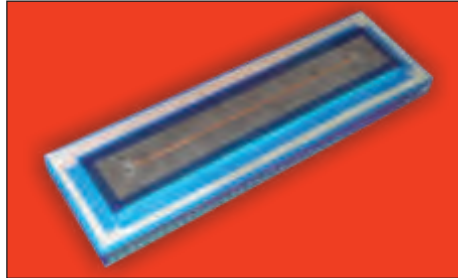
Developed Standalone primary feed array with 3 x 2 elements at S Band with and without Surface Mounted Horn



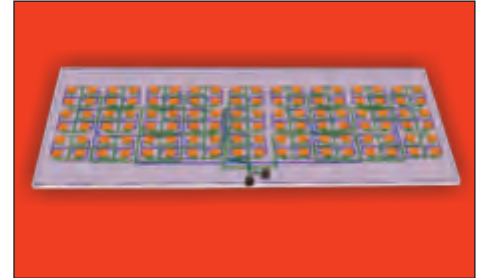
design model of Separable L & S FRAP

MiniSAR

During this year, 6 x 18 dual polarized wideband planar array antenna at X Band element with independent polarization control using Electromagnetic Coupling at V pol and Aperture Coupling at H pol has been redesigned incorporating modifications of Bottom fed input connectors on same side to facilitate back electronics and Design of low loss microstrip to microstrip transition, Customized connector design and 7% mass reduction. Test coupon has been developed to test performance of customized connector in coaxial to microstrip transition.



Test Coupon to test customized connector design



Simulation model of 6 x 18 dual polarized array antenna

Ground Penetrating Radar

Ground Penetration Radar (GPR) works on the principle of scattering of electromagnetic waves to detect buried or sub-surface objects or structures on earth or planetary surfaces by recording RF reflections from discontinuities. It can thus be utilized to gain understanding of subsurface material composition by extracting electrical properties (dielectric constant, loss tangent) of materials. GPR finds its applications in environmental, engineering, archeological and other shallow investigations.

Integrated testing and temperature operational test of 2 Units of Transmitter and Receiver subsystems was completed. All 3 Units of Tx and Rx Subsystem was delivered for system level integration and characterization. Development of 2 units of DPU was completed. T&E of 2 units of integrated Central Electronics Package (CEP01 & CEP02) was completed and integrated CEP with GPR structure. Integration and checkout of GPR v3 (for ISEA 34) was completed.

ADITYA-L1

Aditya-L1 mission is planned to investigate the physical processes of sun like heat of the solar corona, solar wind and coronal mass ejections (CMEs). SAC is responsible for design and development of detection systems of coronagraph. The coronagraph instrument will perform spectroscopic and spectro-polarimetric observation of solar corona. Scientific objectives are :

- Diagnostics of the coronal plasma
- Study the cause of exceptionally high temperature of corona
- Development, dynamics and origin of CME
- Measurement of coronal magnetic fields in the corona

Detectors for visible channels are procured. Preliminary design of DHA is ready. Control and Digital Processing Electronics (CDPE) of BBM of visible channels is developed and tested independently. Detector Proximity electronics (DPE) PCB is under fabrication. Power supply procurement is initiated. Development for SWIR channel is also taken up.



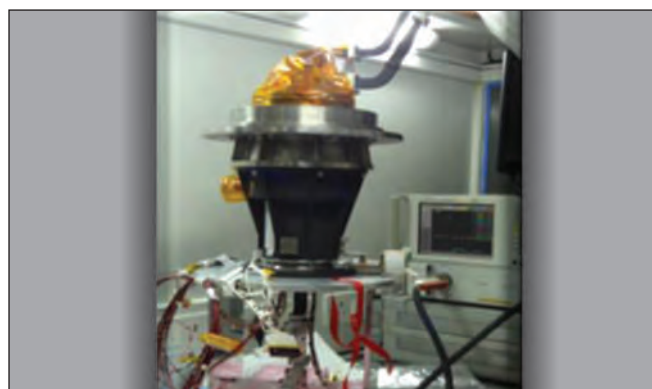
DCPE BBM and Test unit

SCATSAT-1

PDR of SACTSAT-1 was completed on April 29, 2014. DVM Digital Subsystem was delivered to Integration for FM TWTA & FESA revalidation. Action closeouts of SCATSAT Preparatory design review was completed. Revalidation of combined assembly of FESA and two 120W Ku-band Pulsed TWTAs was completed. T&E of FESA EPC was completed. Final patch bracket Electrical Interconnection Details are provided to spacecraft AIT team. Scatterometer Interface Module (SIM) structure was finalized. Integrated testing and temperature operational test (TOT) of Integrated FG (Main) unit was completed. Package assembly and testing of baseband unit (Main & Redundant) of Receiver was completed. Integrated testing and temperature operational test (TOT) of Integrated FG (Main) unit was completed. Package assembly and testing of baseband unit (Main & Redundant) of Receiver was completed. Test & Evaluation of FM Receiver and Frequency Generator (M+R) is completed. New elements W/g FESA LNA and Cross-patching switch was qualified.

The 1m FM reflector antenna with dual offset multi-mode elliptical feeds was delivered after successful completion of test and evaluation at SAC. The spare FM of multimode elliptical feeds of Scatterometer of Oceansat-II has been revalidated for use as FM in SCATSAT-I FM reflector as feed. The IBT and FBT measured results on RF parameters meet the system specifications. For thermal isolation Deldrin spacers have been used in the clamps and CFRP bush for holding the waveguide plumbings.

A new broadband Dual channel rotary joint was designed and developed. DVM was developed and all the RF specifications predicted were met in the first DVM. Based on the encouraging RF results, QM and FM of dual channel rotary joint are developed. The new rotary joint shows excellent RF performance on return loss, insertion loss and isolation over a bandwidth of 200 MHz at 13.525 GHz and the results are at par with the imported rotary joint procured for Scatterometer of /Oceansat-II. The FM rotary joint has been delivered after successful Test and Evaluation at SAC.



FM rotary joint under with FM SSM

OCM-3:

Thermal analysis using both Aluminium and Titanium was completed. Optical design for all bands was completed.

Planetary & Astronomical Missions

CHANDRAYAAN-2

Chandrayaan-2 will cover the moon and supplement/complement Chandrayaan-1 measurements. Terrain Mapping Camera-2 is improved w.r.t. power and weight. Imaging Infra Red Spectrometer is a new camera with spectral range of 0.8-5.0 μ m will measure absorption by pyroxene, olivine and plagioclase minerals to understand the lunar evolution. Miniature camera is being developed for Rover/Lander monitoring.

PDR of Chandrayaan-2 payloads was completed on August 27, 2014. Camera electronics and mechanical integration of payloads is in progress. EMI/EMC and ESD tests for TMC-2 DVM payload was carried. T&E of PSI, SIS & PDAS (second unit) of TMC-2 payload was completed. Electrical interface test between Payload (DVM) and BDH (VM) of TMC-2 was carried out.

Development and testing of first set of Checkout units (SIS & PDAS) of Rover Imager was completed. Thermovac test for Camera Head was completed. QM Rover Imager qualification (batch-A) was completed. Payload Commanding Software for Payload integration was delivered. Rover camera SNR test was completed. Post thermovac test (QM) of Rover imager was completed. Interface test between Rover Imager (VM) and BDH (DVM) was completed at ISAC. Assembly and testing of L & S-Band MMIC driver amplifier of L&S band pulsed transmitter was completed and results are in line with specifications. Testing of S-Band final power stage and medium power stage using Phase-1 qualified component RF5003 and RF5007 was completed and results are satisfactory. Mechanical System Configuration of L & S band SAR is developed. New Sensor was developed for Altimeter. Mechanical System Configuration is in Progress.

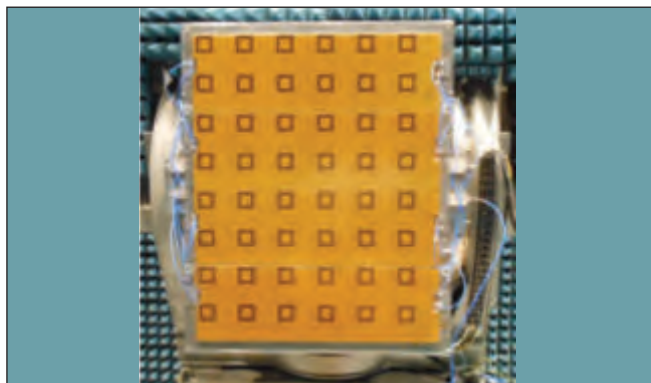
Testing of High Power Amplifier unit and integrated Testing of 1 Watt Transmitter with EPC of Altimeter was completed. Preliminary Testing of Integrated Tx, Rx and Digital sub-systems was carried out. Integrated DVM H/W (Tx, Rx and EPC) is delivered for further integration. Design of Sharp rejection and Broadband Band pass filter at very low IF was completed and loaded for fabrication. Integrated characterization of altimeter for Lander was carried out. Characterization of developmental model of L&S Band Dual Band Dual Polarized Multi Layer Patch Array Antenna (Full Tile) has been completed at PNF and CATF at SAC. Functional testing of LDO ADP3336, Amplifier OP07 and ADC AD128 based temperature biasing and sensing circuit of IIRS was carried out. Testing of three phase inverter circuit with BLDC motor in closed loop position feedback mode through Hall sensors of IIRS were carried out. Optical design for spectral range of 0.4 to 0.7 micron of OHRC was carried out. Design verification model (DVM) of multi layer patch antenna for dual band SAR was developed. Integration of S-band dual polarized standalone FRAP with feeder network for design verification was completed. Software module development for characterization of 12K TDI CCD of OHRC was completed.

During the tenure of this year, design, development and characterization has been completed for SAR antenna of Chandrayaan 2 employing new light weight material and processes. The antenna mass is 3.6 kg. The antenna is fabricated using process identification document(PID) prepared by the expert committee formed by Director, SAC. The antenna is complying all the specifications. The non electrical portions of the antenna are removed using CNC machine resulting into mass reduction. The feeder network for the L band has been improvised enhancing the gain at L band. All the materials and chemical etching on the RT 5880 LZ and copper clad kapton material has been qualified. All the drawings have been approved. The 1/4th

antenna has been subjected to thermo vacuum chamber successfully. The fabrication of qualification sample (1/4th antenna) is in progress. The project has introduced the new frequency 2.1 GHz for orbiter lander communication. The antenna has been characterized for the axial ratio and gain at this new frequency. The



TMC



Full size Common Aperture SAR Antenna

MARS Mission

Mars is an object of scientific curiosity as well as specific inquiries due to similarities with Earth in terms of seasonal cycles and thermal environment which is considered to be conducive to the evolution and development of life forms. MOM is the first mission to the MARS. SAC has contributed significantly by developing three of the five instruments/Payloads for Mars Mission Mars Colour Camera (MCC), Thermal Infrared Spectrometer (TIS) and Methane Sensor for Mars (MSM).

All three payloads; MCC, MSM & TIS; were operated successfully. Performance summary of all three payloads were prepared and given to the project. Algorithm in Matlab for signal dependent noise estimation from MCC images using weak texture patches was developed. MCC and TIS In-orbit Data for months of Oct, Nov, 2014 was processed and generated analysis report.

Astrosat

BDH and TC interfaces was finalized. PRT activity for DPE design for UVIT was completed and design is cleared by PRT for SCRC review. Development of data unpacking s/w module was initiated. Design of all electronics packages was completed and loaded for fabrication for QM models.

ADITYA

Aditya-1 will be used to understand physical processes of the sun like heat of the solar corona, solar wind and coronal mass ejections (CMEs). SAC is responsible for design and development of Detection systems.

Environmental test facility to study the detector output stability in dark Detector was carried out. TC/TM interface was finalized.

Remote Sensing Data Products Applications

INSAT DP (IMDPS) & Special Products Software

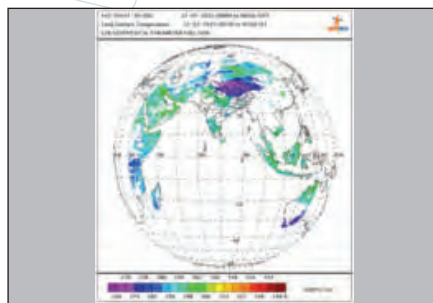
In order to improve navigation accuracy, Fixed Grid Navigation and Automatic Template Based Registration (using Phase correlation and gradient based approach) package for INSAT-3D Imager was developed and operationalized at BES (Bopal Earth Station), SAC and IMD (India Meteorological Department), New Delhi. The Imager data processing software was made robust to cater Full Scan and Rapid Scan Processing automatically based on acquisition mode. Since Sounder chain gives only Earth Sensor attitude data, Real Time Full Day Star Sensor attitude (from AOCS) was used for Sounder Navigation. A new Servo Error Correction Algorithm based on Fast Scan bearing inductosyn temperature was implemented for Imager. The GSICS (Global Space-based Inter-Calibration System) was adopted for radiometric calibration of Imager and Sounder.

A cloud mask using INSAT-3D Imager data was developed using IR threshold and segmentation for cloud classification. Software to generate the colour enhanced cyclone animation was generated. The automatic registration for INSAT-3A CCD dataset was implemented to avoid manual interaction. An algorithm for B1 (LWIR-1) and B2 (LWIR-2) de-stripping/ de-banding of INSAT-3D Sounder was developed and operationalized. A new approach for de-noising of INSAT-3D Imager MIR channel was developed. Incorporated and verified few additional features such as T-Phigram in METGIS Ver 2.0 and installed the package at IMD.

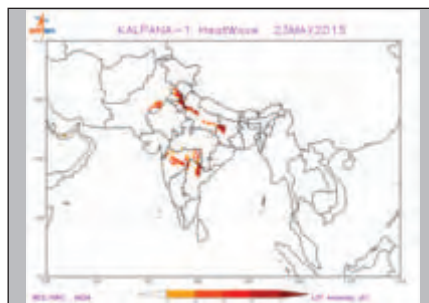
The ADPS (Ancillary Data Products Generation Software) capability enhanced to include HRIT/LRIT products, AWS (Automatic Weather Station) Data Decoding, archival and report generation. The Product Chip Generation Software was updated to include CTBT (Cloud To Brightness Temperature) and contouring of OLR (Outgoing Long wave Radiation), SST (Sea Surface Temperature) and BRT products. The GTS Products decoding Software was provided to IMD.

In 2014-15 a new web based software RAPID (Real time Analysis of Products and Information Dissemination) was developed for near real-time visualization, analysis and animation of INSAT-3D, Kalpana-1 and INSAT-3A products including Geo-physical parameters at IMD, New Delhi and released during IMD annual day on January 15, 2015. The improved accuracy Wind Products such as AMV (Atmospheric Motion Vector), CMV with quality flag was generated in BUFR format, which was assimilated in Numerical Weather forecasting Model at NCMRWF. A Joint validation exercise for Geo-physical parameters was done with IMD.

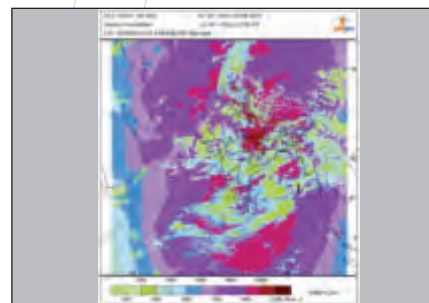
The following are the sample new and improved products added in IMDPS during 2014-2015. The new products were Insolation, LST (Land Surface Temperature), Heatwave, Fog and Wind Derived Products (Convergence, Divergence, Wind Shear, Relative Vorticity). The improved algorithm products were HE (Hydro Estimator) and IMSRA rainfall. The Heatwave condition monitoring from the Satellite Derived LST Products were made operational at MOSDAC. A new High resolution Sector product with district boundary was provided to IMD.



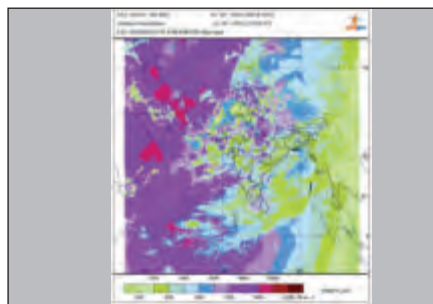
LST



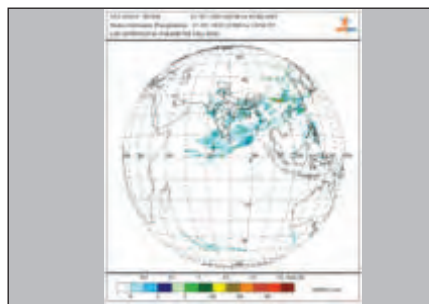
HEATWAVE



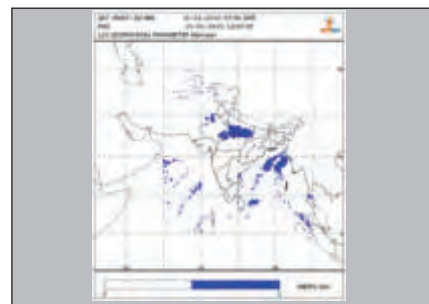
INSOLATION



INSOLATION

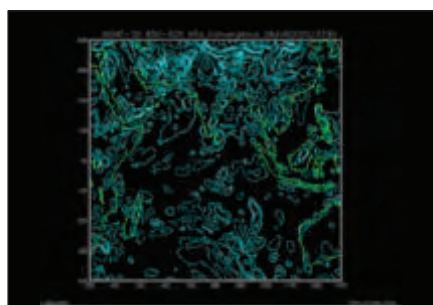


HYDRO-ESTIMATOR

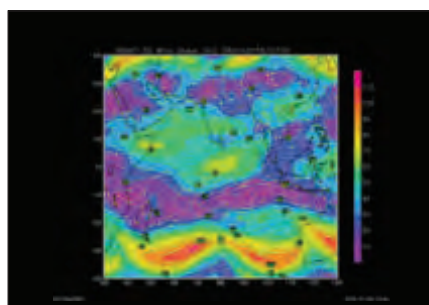


FOG

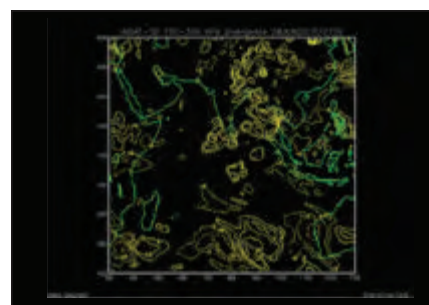
Wind Derived Products



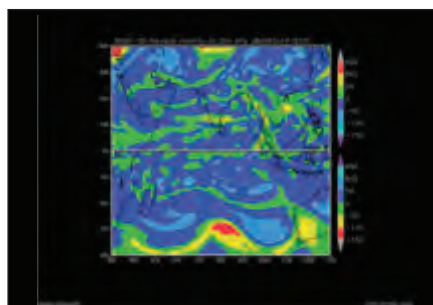
CONVERGENCE



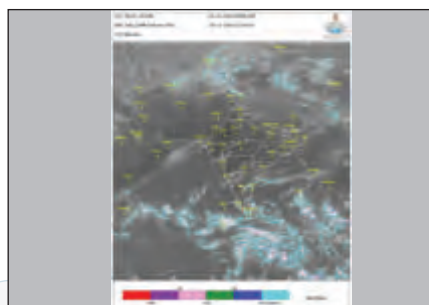
WIND SHEAR



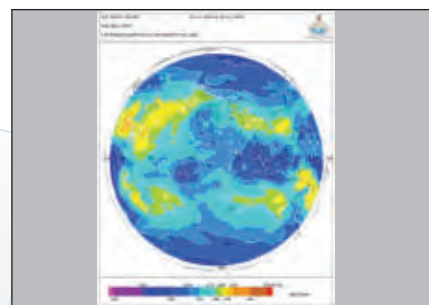
DIVERGENCE



REATIVE VORTICITY



Contour Overlaid products (CTBT)



Contour Overlaid products (OLR)

Snapshot of RAPID

INSAT 3D DQE

INSAT-3D Data Quality Evaluation (DQE) system is operationalised at MOSDAC, where evaluation of basic data products of Imager and Sounder is carried out regularly by using in-house developed DQE software. DQE parameters are defined for evaluation of basic data products to monitor quality aspects related to payload health, system performance and product accuracy. DQE system was augmented with INSAT-3D Quality Analysis System (i3dQAS), an intra-net based portal for data quality monitoring. The portal is designed and developed to provide browser-based access to quality data to various project teams at SAC viz. payload, data products and applications for purpose of temporal analysis of system performance. Following figure shows home & analysis pages of i3dQAS:

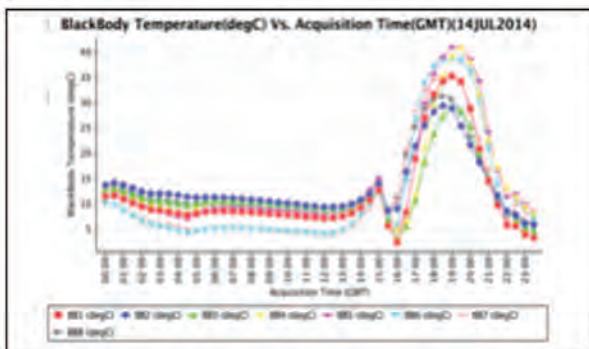


INSAT-3D Quality Analysis Portal : i3dQAS



Geo-location Error Analysis for Imager (May-Jul-14)

Major functionalities of i3dQAS are to systematically archive quality parameters generated through operational DQE procedure, allow users to access quality information through browser, enable users to visualise diurnal/seasonal behaviour of the system and aid in detection of system malfunction or anomaly. Following quality parameters for Imager & Sounder are available for analysis through this portal: a) Payload Health - In-orbit temperatures for Electro-optical module, Cooler, Black-body, Calibration counts for IR channels. B) Product Accuracy for Full-disk & Sector products - Geo-location error, Internal distortion, Platform attitude and Band-to-Band registration.



Diurnal Variation in Black-body Temperature

Subsystem	Max(degC)	Max_Top (GMT)	Max_DOP	Mean (degC)
BlackBody-1	60.321	00:00:00	2014-07-17	12.105
BlackBody-2	30.113	18:30:00	2014-07-11	13.657
BlackBody-3	31.733	00:00:00	2014-07-17	12.371
BlackBody-4	42.399	19:30:00	2014-07-24	14.284
BlackBody-5	43.684	02:00:00	2014-07-07	14.403
BlackBody-6	41.529	00:00:00	2014-07-17	11.902
BlackBody-7	36.351	18:30:00	2014-07-03	11.414
BlackBody-8	32.049	18:30:00	2014-07-06	13.413

Monthly report for Black-body Temperatures

Through this portal user can generate single or multiple date graphical plots for above parameters in specific range of acquisition time and store the results in PDF format, an example is shown in above figure. This portal is available on SACNET for registered users.

CAL/VAL

Lunar irradiance from INSAT 3D VIS channel was computed and proposed Cal/Val activity and presented during the RS- 2A ground segment meeting held at Hyderabad. Cartosat-2 successfully imaged the convex

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RISAT-1 DQE

Performed detailed radiometric analysis over Amazon Rainforest using RISAT-1 Products in different polarizations, beams/incidence angle to study the behaviour of σ_0/γ_0 and reported inconsistency observed; Reported under/over compensated antenna pattern for Level-1 SLC and GR products.

After DP correction (application of updated antenna pattern) and fine tuning in DP software, data products were re-evaluated; 2 technical notes circulated on this analysis. Point target analysis to evaluate RCS and impulse response function parameters over five sites (Indian) carrying trihedral corner reflectors; Results published in JOG. Also, carried out point target analysis of Australian gunning site data and given feedback on the optimum size of CR required for FRS-1 mode of RISAT-1.

IMGEOS DQE

IMGEOS DQE designers resolving bugs and augmenting new requirements using maintenance server on space net since last year. Deployed test version of Auto-GDQE module on DQE test account on NRSC Maintenance system for evaluation of Resourcesat-2 data products. DQE Scheduler and RISAT-1 CALDQE software was updated to support data acquired at Antarctica station. Extraction module for Cartosat-1 products in HDF format was uploaded to the software repository at NRSC.

ScatSat-1 DQE

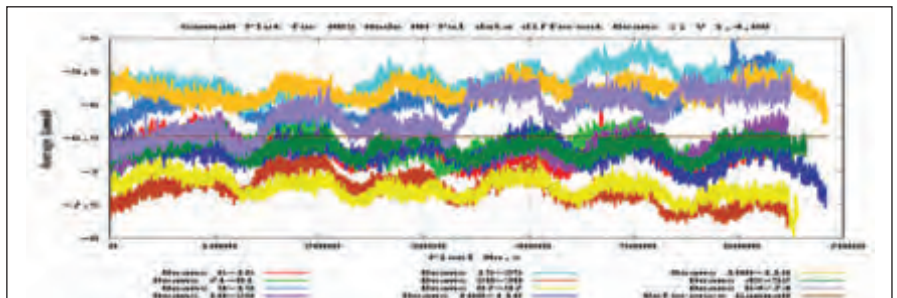
Identification of DQE parameters for ScatSat-1 at Level-0, Level-1B and Level-2A was done for fully auto-mode of operations and detailed analysis. Software development completed for Level-0, Level-1B and Level-2A DQE parameter evaluation and report generation for initial sets of defined parameters. Approach formulation done for back tracing the anomalies seen in higher level data products to lower level data product for problem identification.

RapidScat DQE

Carried out a detailed analysis of RapidScat Level-1B data product in terms of monitoring orbit, system behaviour and static/dynamic parameters. This study was carried out by analysing around 500 Level-1B data products of RapidScat.

RISAT-1 DP

The license generation and validation software for International Ground Station (IGS) was developed. Internal and integrated testing and evaluation for RISAT-1 DP software for KSAT-IGS was carried out. Factory Acceptance Test for the software was performed at NRSC. RISAT-1 DP was operationalized at IGS station (KSAT) and provided training to KSAT personnel. Code to generate Level-2 product for polar region using polar stereographic map projection was developed. 32 bit CEOS SLC Data Product for DLR Site Corner Reflectors was generated and provided the product to NDC for dissemination to user. Provided utility on NRSC web site to generate Level-2 data from Level-1 ground range data of user interest. Provided an alternate chain at NRSC operational setup to generate data products for scansar scenes with insufficient overlap between beams. Updated RISAT-1 DP with new antenna pattern and improved calibration using amazon forests data. With the current operational version, Relative Radiometric accuracy achieved is within 1 dB and Absolute Radiometric accuracy achieved is within ± 1 dB for 18.00 to 55.00 incidence angle range in both left & right look directions look angle.

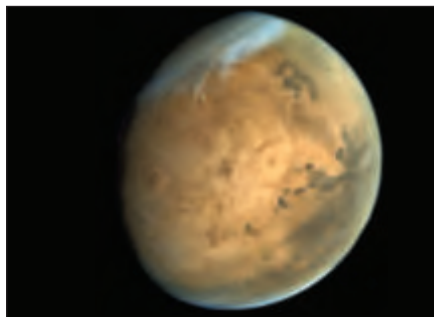


MARS DPS/W

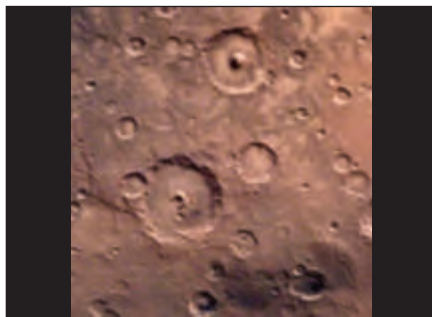
MOM science data processing system is an automation-intensive in-house developed software solution to streamline the work flow in a processing chain for MCC, TIS, and MSM instrument data transforming telemetry data comprising both primary and ancillary into different levels of science data products processed for radiometry and geometry aspects following established universal standards to incorporate all acquisition, calibration information, processing context details to be archived for long term use. Data acquired during Sep, 2014 to July, 2015 are duly assessed, processed and disseminated to science teams from ISSDC and SAC POC portal. MCC images are geometrically and photometrically corrected to produce many value added products for science analysis and public outreach. Many utility softwares were developed to support data visualization and analysis.

Development of Mars Visualization Tool using MDIM and MOLA DEM was completed. MCC Earth/Mars Bound Phase Geometric Accuracy Evaluation exercise with reference data sets was carried out. Mosaics, HDR image, Anaglyphs were generated from MOM first day product and from globe images of Mars and provided to the mission for public outreach. MCC, TIS & MSM in-orbit data was processed, analyzed and

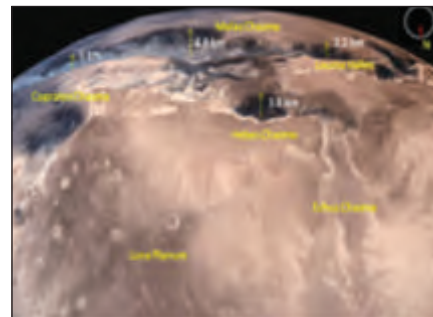
report was generated. All acquisitions from MCC, TIS, MSM, LAP and MENCA (active archive generation) instruments till July, 2015 have been processed.



High Dynamic Range (HDR) image generated from MCC frames of Mars Disc



Topographically corrected MCC image from Burton and Cobres craters, Mars

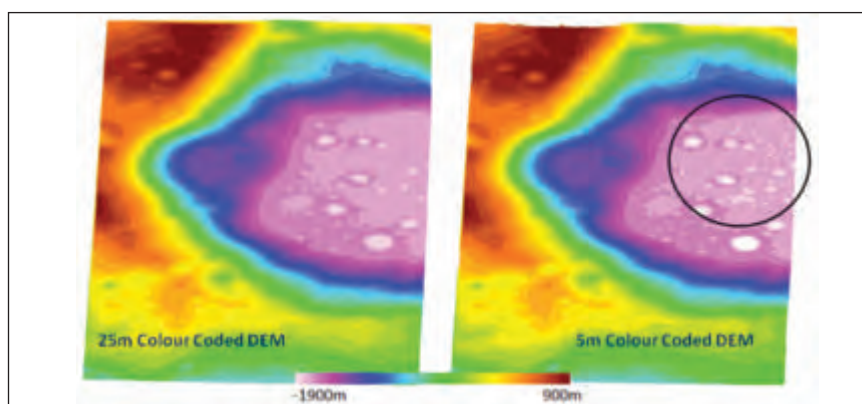


Valles marineris terrain visualization using 3D planet tool using MCC data

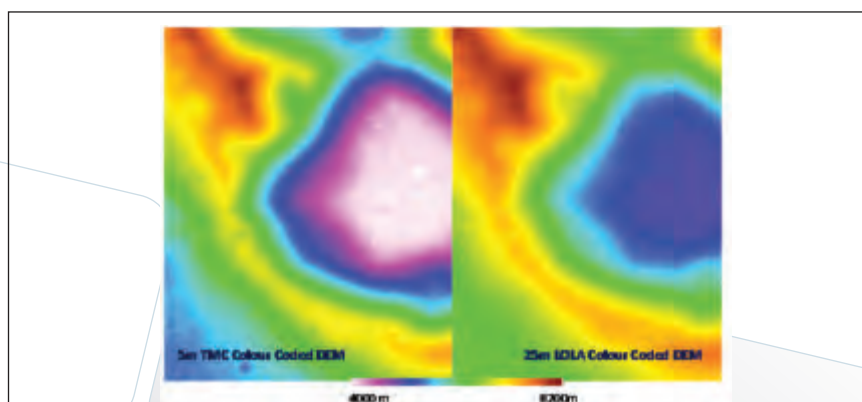
Chandrayaan-1

Lunar Digital Elevation Model Generation (LDEM)

Lunar DEM generation at 10m grid spacing and ortho image at 5m resolution for 691 orbits of Terrain Mapping Camera using Nadir and Aft sensor data got completed. Planimetry and vertical height accuracy assessment for 595 orbits got completed and remaining are in progress. Activities for dissemination of DEM and Ortho image through ISSDC, Bangalore is also in progress. A case study and exercises were taken up to generate DEM at every pixel (5m) on certain orbits and conducted detailed analysis of 5m and 25m DEM from Chandrayaan-1 and compared with LOLA DEM. It is observed that more details are coming out clearly in 5m DEM than 25m DEM, as illustrated in the following figures.



The following shows improvement on 5m DEM from Chandrayaan-1 over LOLA DEM.



Chandrayaan-2

Completed Landing site Selection for Chandrayaan-2 Lander by analyzing 74 sites (57 in the South Polar Region and 17 in the North Polar Region). Detailed topographical analysis was carried out for these sites and 04 sites were selected in the 85-90 degree latitude region. Algorithms have been developed for calculating terrain waviness and roughness from Digital Elevation Model. Developed algorithms for crater detection and crater catalogue development. Crater based landmark detection algorithm was developed and implemented it in "C" language. Rover Image Processing test facility at SAC Bopal campus was augmented. Rover Camera Calibration exercises was completed using the Matlab for the Navigation Camera images. First level development of CAHVOR model for object point determination was completed.

Scatsat-DP

Identification of DQE parameters for ScatSat-1 at Level-0, Level-1B and Level-2A for fully auto-mode of operations and detailed analysis was carried out. Software development for L1B DQE parameter evaluation and report generation for initial sets of defined parameters were completed. Algorithm development for the statistical evaluation of L2A products of OSCAT payload was completed. Augmented DP software to generate data products for 25 km and 50 km grid. Carried out parallelisation of L1B and L2A code to improve processing time. Work out computer configuration for operational DP generation. Generated global Land-Sea data base at 500 meter resolution.



Land sea data base

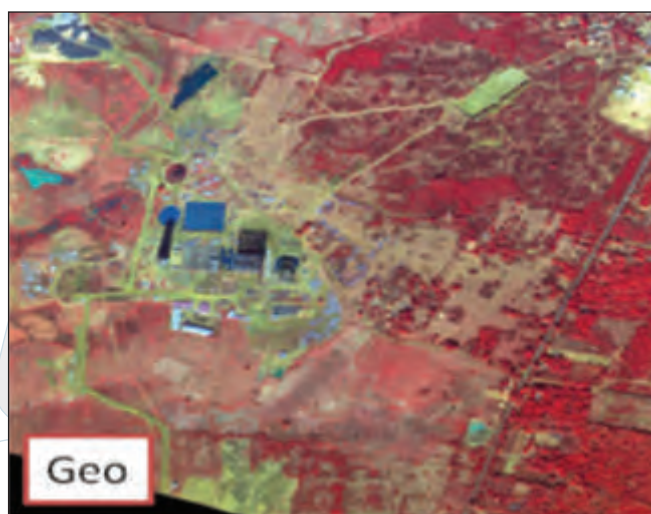
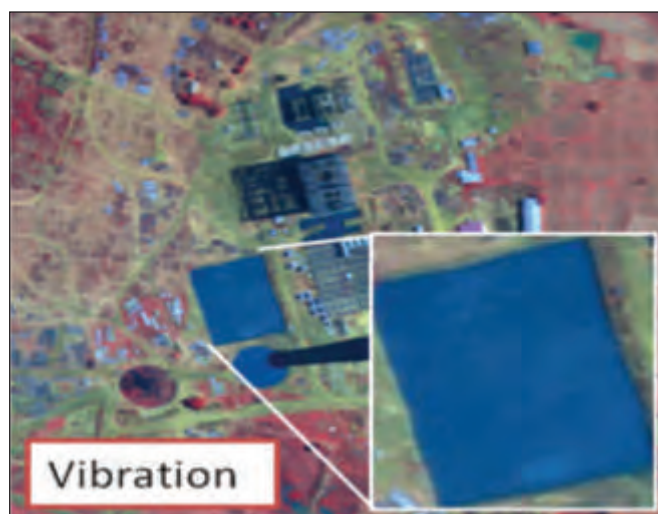
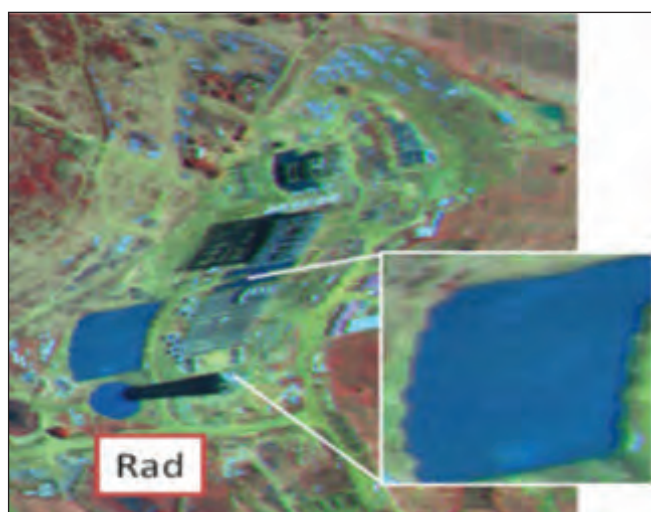
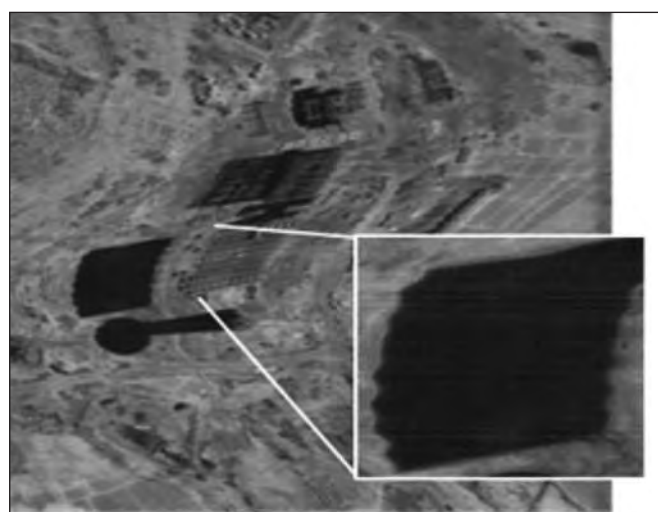
Astrosat DP

Data Products Team, SAC have developed software for processing data from four payloads of Astrosat, India's first dedicated astronomical satellite slated for launch in September 2015. Quick Look Display (QLD), Level-2 Science Data Processing and Archive, Browse and Dissemination are the three software packages designed for processing of data from Astrosat instruments viz. Cadmium Zinc Telluride Imager (CZTI), Large Area X-Ray proportional Counter (LAXPC), Soft X-ray Telescope (SXT), Ultraviolet Imaging Telescope (UVIT). Design and development of QLD (Ver 2.1) and Level-2 (Ver 1.0) s/w were completed and these have been ported to ISSDC, Bangalore and had already undergone internal as well as external T&E. Internal T&E of Archive, Browse and Dissemination s/w is planned soon and will be deployed at ISSDC before launch. These software components will be used after launch during Performance Verification (PV) phase as well normal phase of operations for astronomical study and science data analysis. Level-2 s/w will be deployed at various Payload Operations Centre(POCs) viz. IUCAA, TIFR, IIA, RRI, NCRA for use by respective Principal Investigators(PIs) and their team. However, Level-1 data and Level-2 s/w (executables as well source) will be available to the general users after a lock in period through browse and disseminations facility.

Sr. No	S/w Package	Deployment and Phases
1	QLD (Server and Client)	ISSDC (PV and Normal phase)
2.	Level-2 s/w for CZTI	ISSDC (PV) and IUCAA (Normal)
3.	Level-2 s/w for LAXPC	ISSDC (PV) and TIFR & RRI (Normal)
4.	Level-2 s/w for SXT	ISSDC (PV) and TIFR (Normal)
5.	Level-2 s/w for UVIT	ISSDC (PV) and IIA & NCRA (Normal)
6.	Archive, Browse and Dissemination	ISSDC (PV and Normal phase)

Airborne DP

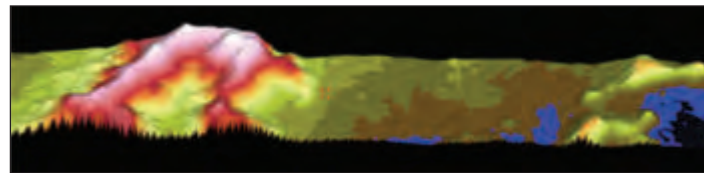
Data processing of Airborne AHYSI payload was demonstrated and explained to ARC ,ADRIN and SASE teams. Developed Software for SpEctral Data analysis (SEDAN) of binary image for various airborne sensors data. Software for geocoding of Airborne Sensors like AHYSI, Anano, ATMC and AIMS-2 data for both nadir and oblique viewing geometry was developed. L1A , L1B , L1C , L2A products for Airborne 4 , 5 & 6 campaign with better radiometry and geo-location accuracy was regenerated. Developed software to compress and decompress geo-coded images to handle large volume of data by avoiding blank pixels and using effective no. of bits. (Compression achieved is around 85%). Data product document was prepared.



Data after various levels of corrections

ATMC Data processing

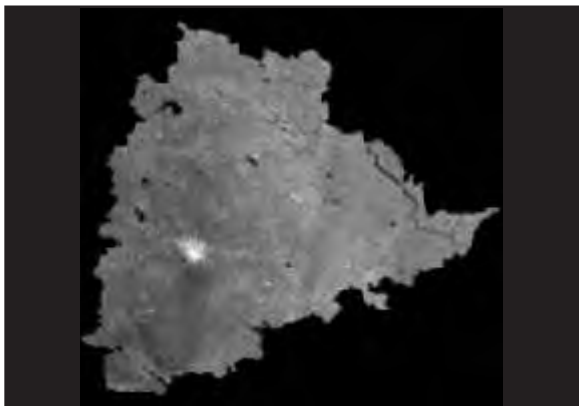
Triplet data acquired by AirBorne Terrain Mapping Camera(ATMC) was studied/analysed for DEM and orthoimage generation. Software for DEM generation was adopted from Chandrayaan-1 with the modification accounting for earth model and the payload model. ATMC DEMs were generated with various combinations of stereo and triplets (FAN, FN, AN) which were further analyzed for the visual quality & geometrical accuracies. DEM with 1m grid interval give more details of the ground features as compared to SRTM & CartoDEM. Full strip DEM & orthoimages were evaluated and accuracy of the orthoimage is found to be better than 10m, using CartoDEM & Carosat-1 orthoimages as references. ATMC 1m DEM overlaid on CartoDEM and draped images are shown below.



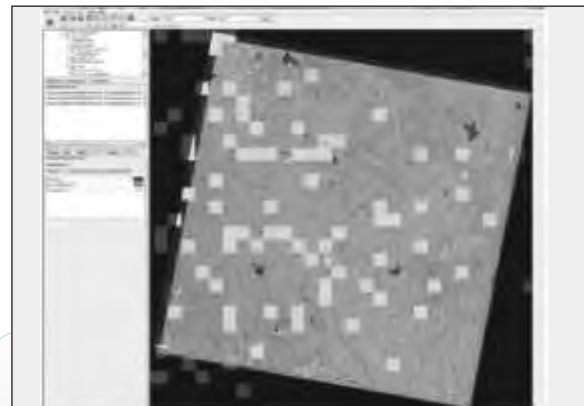
Orthoimage draped over 1m DEM

FASALSoft

Telengana state has been added to FASALSoft configuration for forecast activities. Sampling plan for Kharif Rice is updated from year 2014 in FASALSoft Databases. Onsite s/w services were provided to NCFC-New Delhi to setup new forecast activities.



RISAT-1 MRS data Telangana State Mosaic



Multi Date RISAT-1 MRS data under updated sampling grid for classification during Kharif Rice forecast, aug,2014

Global DEM

Digital Elevation Model (DEM) or Digital Surface Model (DSM) is successfully generated for India and its neighboring countries using CARTOSAT-1 stereo data under CARTODEM project. Under the Global DEM project, improved algorithms (full pass processing instead of a small part of pass) and new utilities are designed to generate DEM for full globe. The proto-type GLOBAL DEM software was developed and tested with limited data sets (26 paths, Fig: 1) covering small part of South America continent. The results were presented in various management meetings. It has been decided to generate 5m Global DEM with available CARTOSAT-1 stereo data sets. NRSC team has provided additional data sets (225 paths, Fig: 2) covering South America continent. DEM generation and qualification using these data sets is in progress.

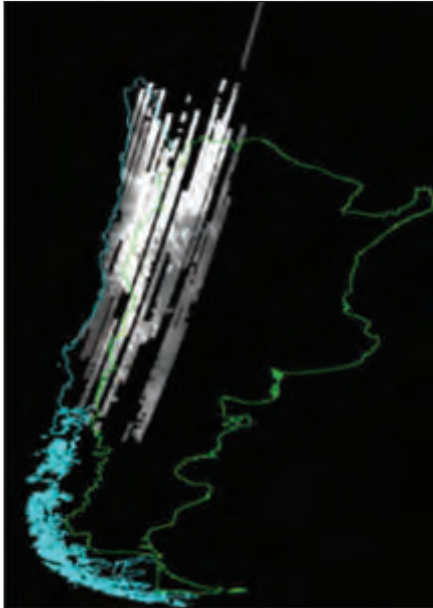
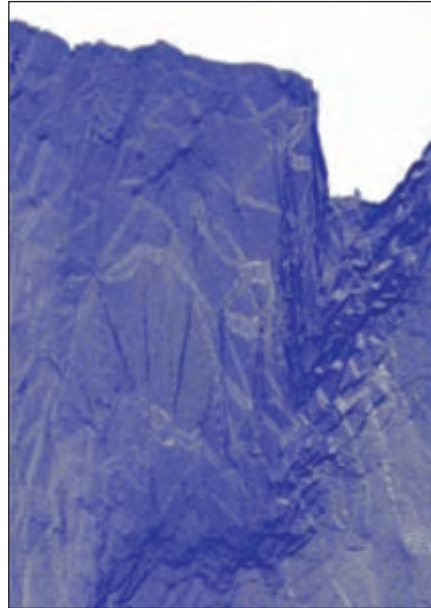
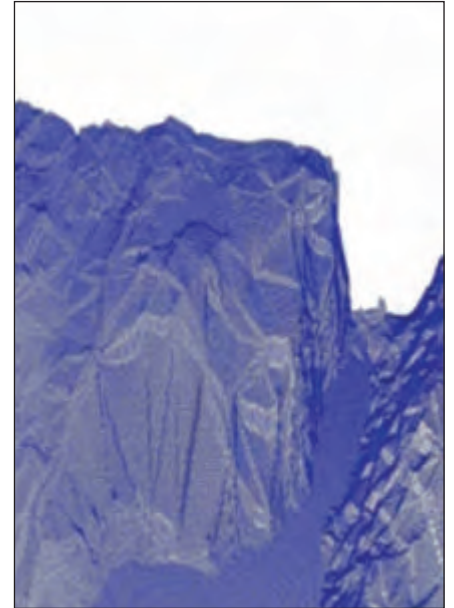


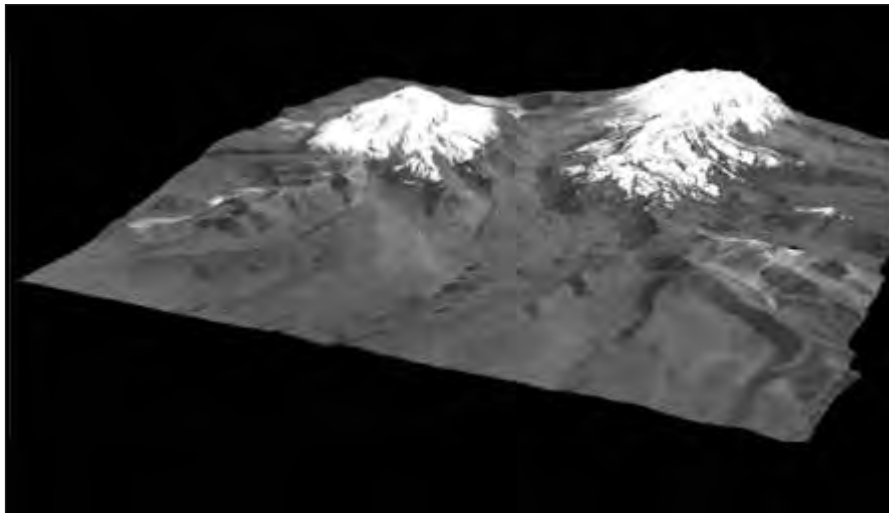
Fig 1: DEM generated as part of Proto type software development



LOA River, before pit filling



LOA River, after pit filling



Andes-DEM



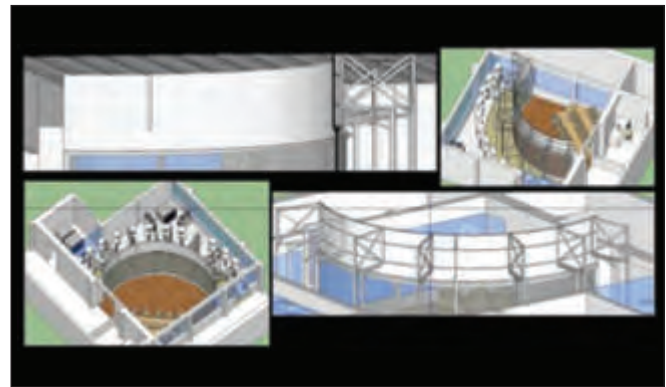
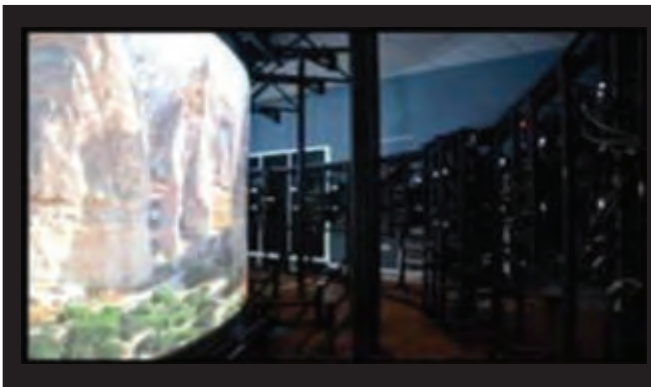
Fig-2: DEM generation in progress for 225 paths over South America

IMGEOS - IRS Data Processing

Continued maintenance of DPGS software for Cartosat-1, Cartosat-2, Cartosat-2A and Cartosat-2B at NRSC by providing solutions to various operational issues and catering to new requirements. Established operational chain for generating Cartosat-2 terrain corrected products using Cartosat-1 reference images and DEM in order to realise improved geo location accuracy at products level (better than 15m). Also, operationalised data processing s/w chain for generation of C2A and C2B products at par with Cartosat-2 DP in IMGEOS.

PLASIV & HPC

PLASIV system was realised and Qualification was carried out. Site readiness and screen installation was over. An application to generate interactive 3D fly-through of various satellite data was developed. Demo contents of satellite images were experimented on content generation and Image generation systems and on screen for seamless fly-through projection were demonstrated to Director, SAC and Chairman, ISRO. The COTS software ERDAS, ARC GIS, World viz, techviz and Microsoft Visual studio have been made available at PLASIV facility and OpenGL and worldviz executables are running on 12000 x 3000 stereo display. A software environment is configured to enable immersive viewing at adequate rendering rate for 12 persons is achieved successfully.



Planetary Simulation and Immersive Visualisation Lab

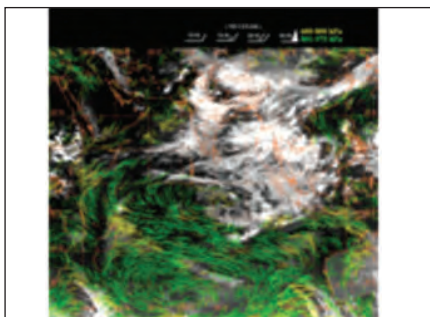
High Performance Computing system has been used for bulk processing and re-processing of RISAT-1, Megha-tropiques, Oceansat-2 scatterometer and Carto-DEM processing.

Earth Observations Applications

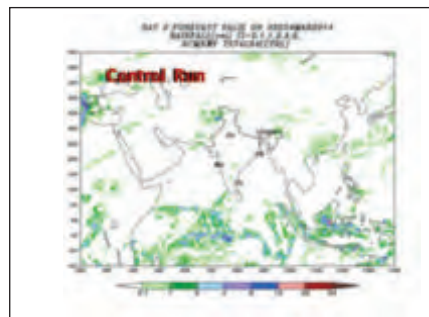
Earth Observation applications at SAC cover projects/activities in the field of Physical Oceanography, Satellite Meteorology, Agriculture, Environment (Terrestrial, Coastal and Marine), Water Resources, Climate change and Planetary Science. The activities are carried out under a number of programmes linked to Indian EO satellites and available data from global sources. The projects are sponsored by user ministries in addition to ISRO-DOS funding.

INSAT 3D Data Utilization

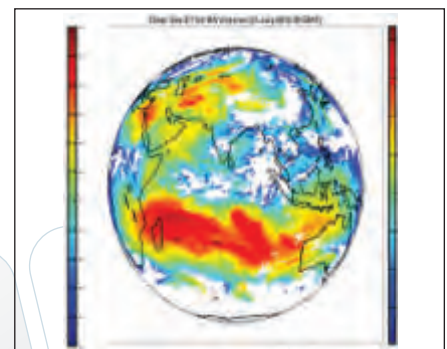
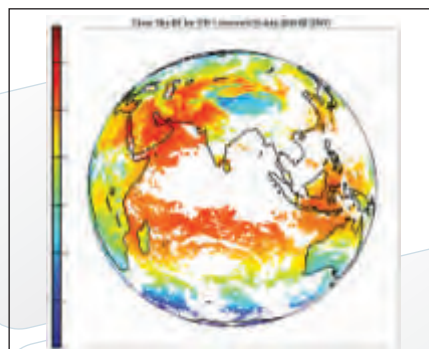
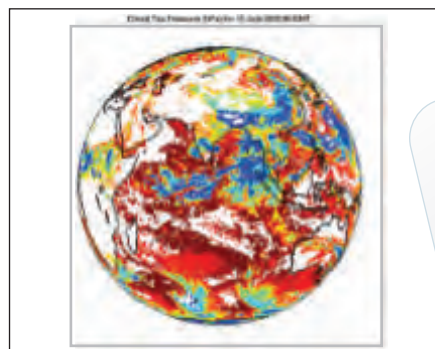
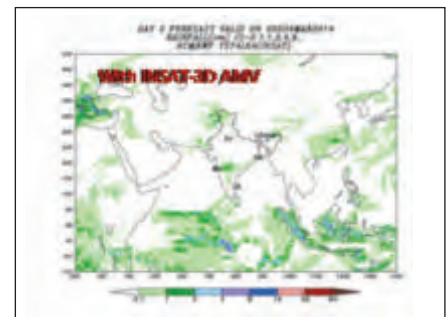
Application of INSAT-3D derived atmospheric winds in Operational model: Atmospheric Motion Vectors (AMVs) are derived operationally using different spectral channels viz. infrared, water vapor, visible and mid-infrared of INSAT-3D satellite every 30-minute covering the area 50°S -50°N, 0°E - 130°E. Vertical ranges of these winds are from 975 hPa to 100 hPa. These are only source of winds in the data sparse regions viz. large oceanic areas. The operational retrieval algorithm is running at India Meteorological Department (IMD) New Delhi and Space Applications Centre (SAC) Ahmedabad. The derived AMVs are distributed through GTS to global users. In India, the major users of these AMVs are India Meteorological Department (IMD) and National Center for Medium Range Weather forecast (NCMRWF). The other international operational numerical weather prediction centers viz. UK Meteorological Office; European Center for Medium Range Weather Forecast (ECMWF) has also started using these AMVs. The application of INSAT-3D AMVs is demonstrated in NCMRWF operational model.



Low-level monsoon winds derived using INSAT-3D data valid at 1200 UTC of 13 July 2014

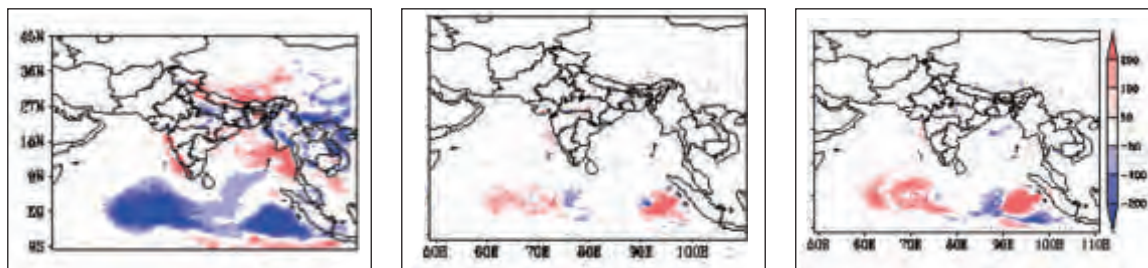


Assimilation of INSAT-3D AMVs have shown improvement in Day-2 rain forecast over north-west and central India, which is absent in control simulation.



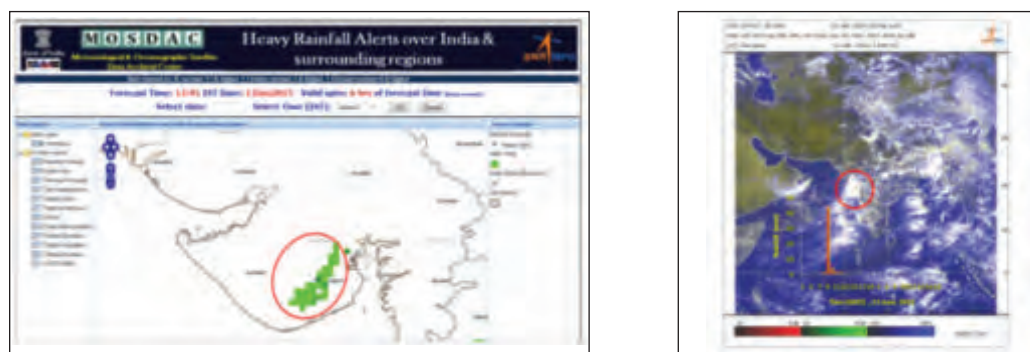
(a) Cloud top pressure, (b) clear sky BT for TIR-1 channel and, (c) clear sky BT for WV channel, generated from INSAT-3D imager observations (15 July, 2015)

Assimilation of INSAT-3D radiances for improved weather prediction: After a thorough monitoring of the INSAT-3D radiances, the capability to include the INSAT-3D radiances, as a new observation in the data assimilation system of WRF Model, has been developed. To investigate the impact of the INSAT-3D clear-sky radiances on the weather analysis and forecast, assimilation experiments spanning entire month of July 2014 were performed using the WRF and its three-dimensional variational data assimilation system.



Accumulated rainfall (mm) for July 2014, (a) Observed minus CNTL predicted, (b) [absolute (observed minus CNTL predicted) minus absolute (observed minus IMG predicted)], and (c) [absolute (observed minus CNTL predicted) minus absolute (observed minus SND predicted)].

Heavy rainfall alerts using satellite data: For the first time a satellite based nowcasting model has been developed to provide heavy rainfall alerts over the whole Indian region. From the onset of the monsoon 2015, all-India heavy rainfall alerts, updated every half hourly are thus being posted in real time through MOSDAC website using this model.



Heavy rainfall over Saurashtra region observed by INSAT-3D image (left) with AWS rainfall (Inset). Alert about the same event has been given by SAC Heavy Rainfall Alert Model (right).

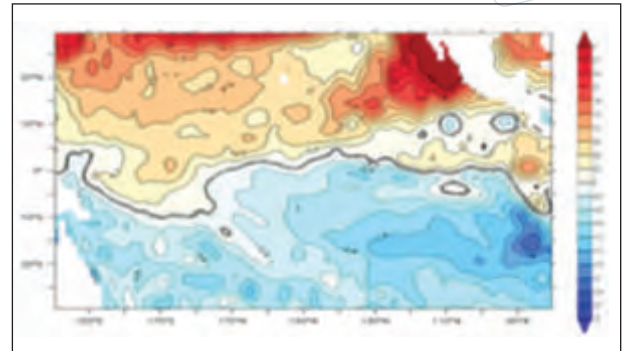
Assessment of long-term changes in Indian monsoon in backdrop of climate change: Based on long term analysis of gridded temperature and rainfall data, it was observed that there is a decreasing trend in All India Summer Monsoon rainfall. Most contiguous and steep decrease was noticed in the North-East India.

Monsoon rainfall prediction using multi-model approach: A similarity based multi-model ensemble approach was developed to predict 1-15 days monsoon rainfall using the rainfall forecast from four global models viz., ECMWF, NCEP, UKM and CMA available from TIGGE dataset. The forecasts from similarity based multi-model are disseminated through MOSDAC web-site in the real-time.

Land Surface Temperature (LST) from INSAT-3D Imager: In order to retrieve the land surface temperature (LST), a view-angle dependent split-window method was developed for the INSAT-3D Imager observations. This method uses the differential absorption tendency of two thermal bands of Imager located in the atmospheric window between 10.3-11.3 μm and 11.5-12.5 μm for LST retrieval.

Meteorology & Oceanography Programme

Data Assimilation in Storm Surge Model: As a part of ISRO's Disaster Management Program, an advanced assimilation technique to ingest altimeter data (includes SARAL/Altika) in storm surge model developed and tested for cyclone Phailin. This led to improvement in the surge-height prediction up to 20%. Model simulated surge height shown in the adjoining figure.

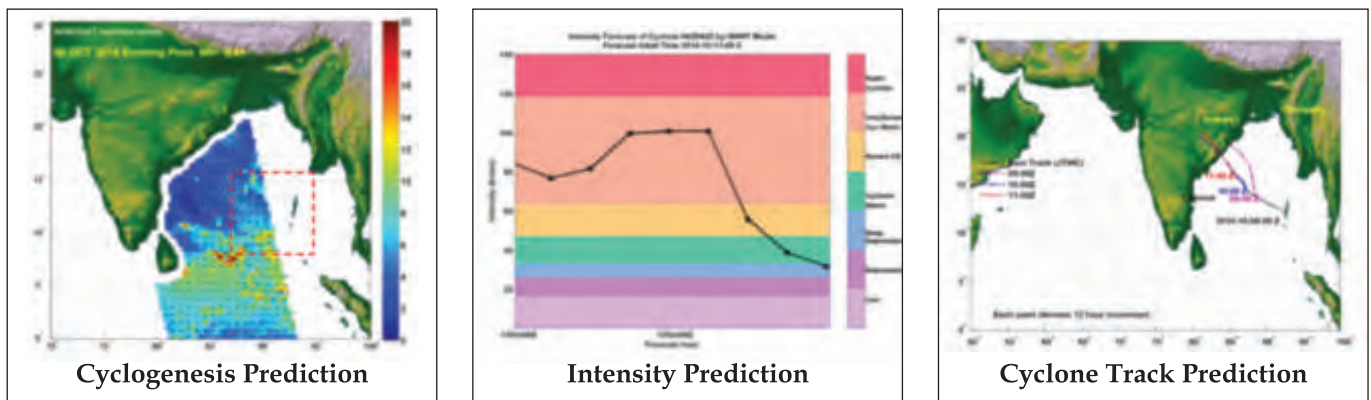


El Nino Outlook for 2014: Occurrence of El Nino in the Pacific has a strong linkage to Indian Summer Monsoon. Towards this, an outlook for 2014 El-Nino was made. Six months in advance, the outlook suggested neutral conditions (No El-Nino) in the equatorial Pacific for December 2014. Sea surface temperature anomalies (oC) for July 2014 is shown here.

Coupled Bio-Physical Modeling: Ocean surface chlorophyll is an integral part of ocean productivity. In order to circumvent the problem of non-availability of optical data under cloudy conditions, an integrated approach making use of satellite and numerical model has been employed. A sample output of chlorophyll simulated by model after assimilating satellite data is shown for January 2006.

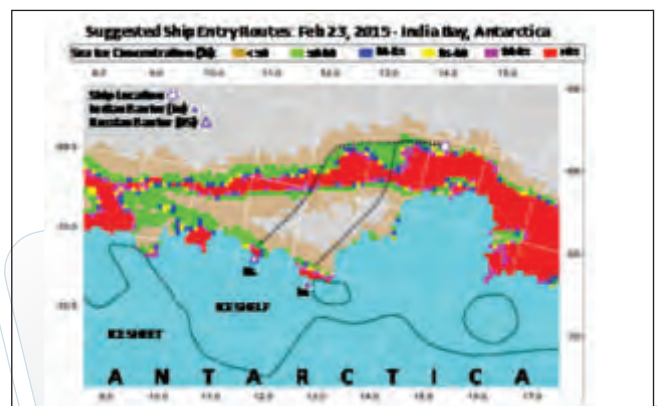
Thermal fronts in Bay of Bengal - Need for high temporal resolution SST: Thermal fronts are very important for biological activity and air-sea interaction. Variability of winter time thermal gradients studied using high resolution (1 km) satellite data. This preparatory exercise was carried out keeping in view the forthcoming GISAT mission. Spatial thermal gradients (oC/km) for January 2010 are shown in the figure.

Real-time prediction of tropical cyclones: Real-time prediction of tropical cyclones formed over the north Indian Ocean was generated using satellite observations and in-house developed algorithms.

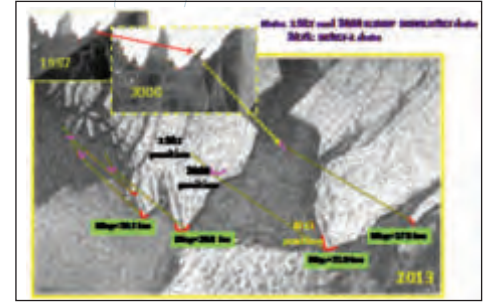


Real-time prediction of tropical cyclone HUDHUD (8-12 October, 2014)

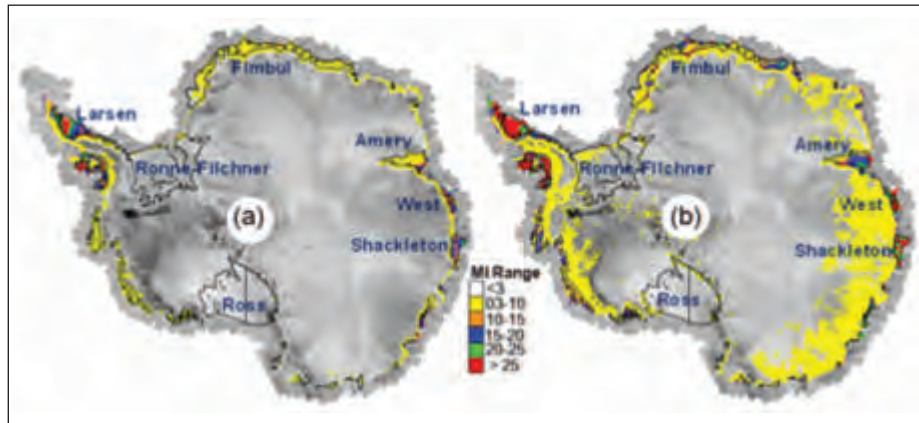
Ship Route Advisory - Antarctic Expedition: Ship routing through sea ice is a critical element for the scientific expeditions to Antarctica. Satellite-based advisory were provided to 34th Indian Scientific Expedition to Antarctica (34ISEA) during January to March 2015 for safer navigation. Satellite data products comprised of RISAT-1 SAR, Resourcesat-1 AWiFS / LISS-III / LISS-IV, SARAL/AltiKa, Terra/Aqua MODIS, AMSR2 ASI. An example of a Sea Ice Advisory image showing Entry Routes to India Bay at Antarctic Coast near Maitri station is shown.



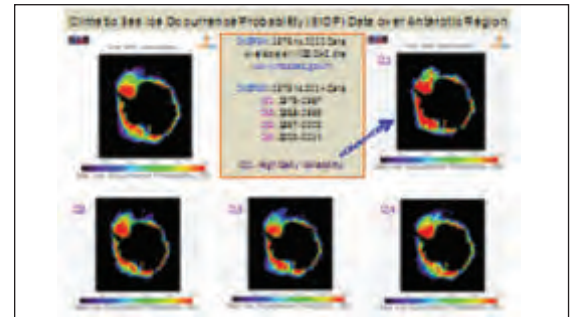
Large scale coastal deformation around Antarctica: In the era climate change, large scale changes are taking place around Antarctic coasts. Multi-year, multi-date SAR data analysis over Antarctic coastal regions between Bharati and Amery Ice Shelf suggests large scale calving and deformation. SAR data (RISAT-1 and Radarsat) and Optical Data (MODIS) were used. An example of coastal ice displacements is shown.



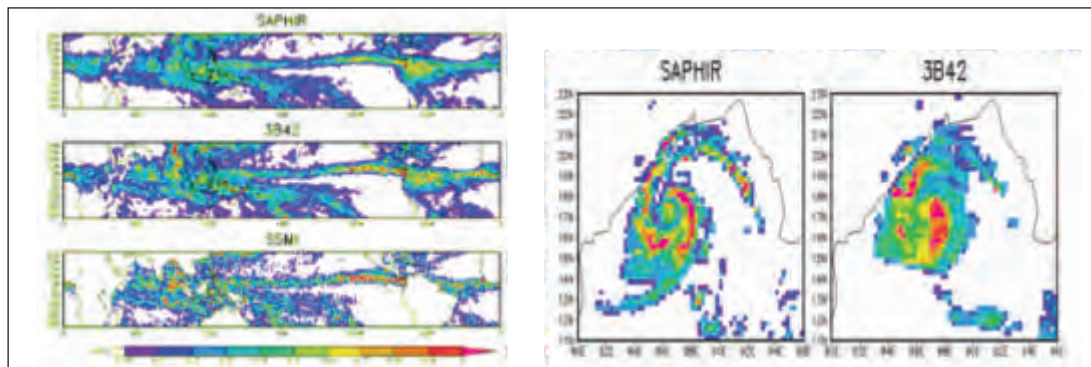
Antarctic Science data for researchers: A daily Climatic Sea Ice Occurrence Probability data over the Antarctic region has been prepared from last 36 years (1979-2014) sea ice concentration data. Data made available to global scientific community through www.mosdac.gov.in. The application potential of this data set has been demonstrated by SAC.



Melting Ice-sheet - climate change vulnerability: Changing climate is affecting the melting conditions of ice sheets/shelves in Antarctica. Satellite based monitoring using scatterometer data analysis shows traces of ice melting in both parts of Antarctica i.e. West Antarctica as well as East Antarctica. Satellite data derived Melting Index (MI) values over Antarctica are shown in figure (a: average value; b: maximum value).

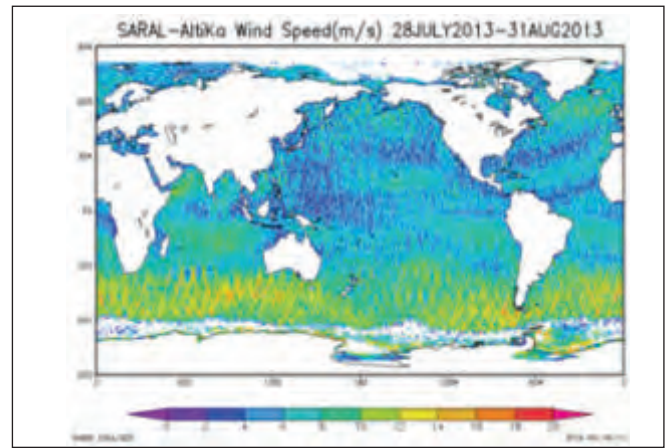


Rainfall retrieval from SAPHIR: After MADRAS stopped functioning properly, SAPHIR high frequency channels have been explored for the retrieval of rainfall. A probabilistic rain identification algorithm and A RT supported rain retrieval algorithm is developed. Only two examples are shown below for brevity.

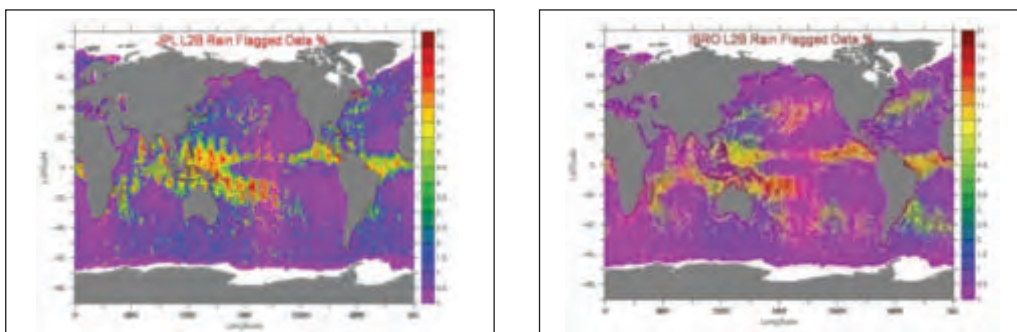


Distribution of rain rates (mm/hr) over global tropics & cyclone Phailin on 11 October, 2013

SARAL-Altika: Development of Geophysical Model Function: Two algorithms for the estimation of wind speed from Altika has been developed. First method is based on a theoretical Geophysical Model Function (GMF) using forward model simulations for Ka band specifications. The second is the model function developed using the matched data base of input and output vectors of Normalized Radar Cross Section (NRCS) from Altika and wind speed measurements from concurrent Jason-2 altimeter. Since the NRCS depends on both the surface roughness due to surface wind speed and on mean square slope of the surfaces, the significant wave height is used along with wind speed for model development as an proxy variable.

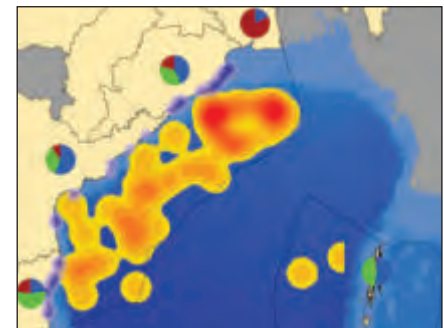


Scatterometer Applications: Performance of the new rain-flagging algorithm (Implemented in ver 1.4 reprocessing) has been analysed. Analysis along with JPL team had shown that the performance of in-house developed OSCAT GMF, Wind Retrieval and Rain-flagging algorithms are at par with International Standards. algorithms for generating climate quality wind products.



% Rain flagging in OCEANSAT-II

Marine Living Resources Management: Empirical Algorithm for Chl-a concentration has been developed for Chilika Lake. SeaWiFS data at 9 km pixel resolution for twelve years period have been processed to generate time series of chlorophyll images. Generalized Additive Model has been developed in GIS for indicating catfish & Squid habitat off Gujarat. The coastal inundation along the southern spit of Chilika Lagoon has been simulated using numerical model.

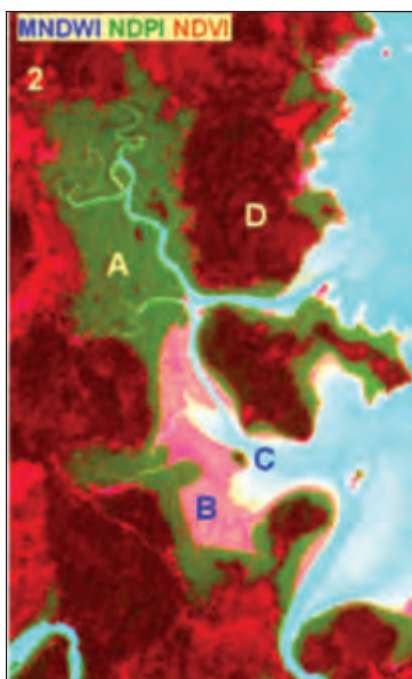


Turtle Habitat mapping

Modelling Coastal Sediment Transport and its Impact on Coastal Environment: Based on EOF analysis on sequential OCM derived suspended sediment concentrations over Gulf of Kachchh region, Hydro-meteorological forces are classified in the order of precedence of influencing the sediment dynamics of the region. Surface elevation due to coastal waves has been simulated along the coast of Mangalore region and slope due to waves has been calculated. Shoreline change along Gopalpur coast has been modeled for 2007 to 2010 and validated with 2010-LISS-4 delineated shoreline. Ocean surface currents have been derived using MCC method along the coast of Krishna-Godavari delta and validated with HF-radar current vectors. Developed a method to derive Eutrophication In(EI) dices using Insitu water quality data of Chilika Lagoon. The derived EI is useful for understanding the status of "Eutrophication state" within the lagoon.

PROGRAM ME on Climate change Research In Terrestrial environment (PRACRITI)

Biophysical characterisation and site suitability analysis for Indian mangroves: Mangrove wetlands play an important role in stabilizing shorelines and protect the coast by acting as barriers against storm surges and heavy tides. They act as sink for sediments and detritus draining from coastal catchments and help in the tertiary assimilation of wastes. Mangroves serve as unique habitats for wild animals like tiger and harbour large number of birds, larvae and juveniles of fishes significant to the fishery resources. Based on the remotely sensed data in conjunction with in situ measurements, mangroves of Indian coast are being studied for their characterization, gross primary productivity and site suitability for plantation/ afforestation.



- A: Mangrove**
- B: Inter-tidal Mudflat**
- C: Creek**
- D: Other Forest/Vegetation**

Mangrove ecosystem components and their discernability through Resourcesat-2 LISS-III (1) FCC and (2) pseudo colour composite of spectral indices) Porlob Jig, Rangat Bay, Middle Andaman

Total diurnal photosynthesis-pE (gC/m²/day) and maximum light use efficiency-ε₀ (gC/mol photons) in summer, Pichhavaram, Tamilnadu

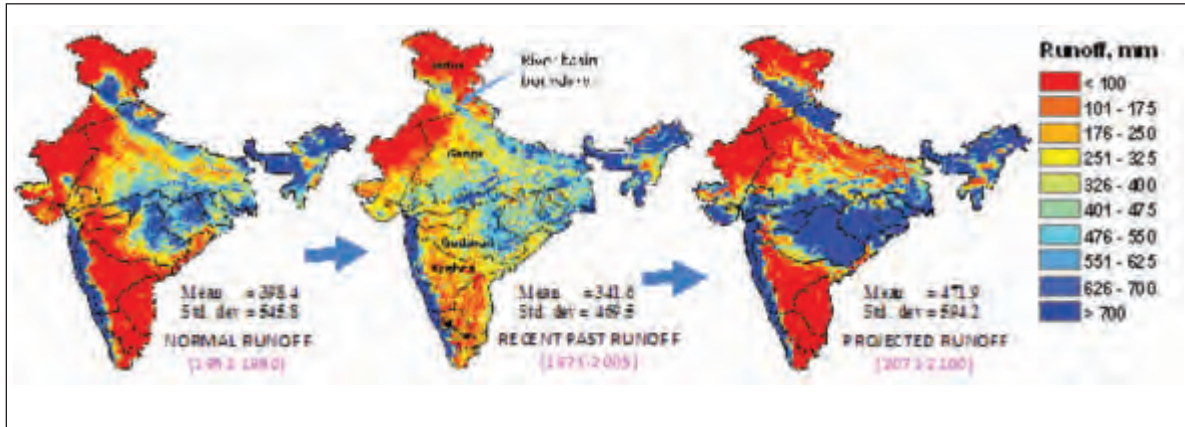
Season	L1 Sun-leaves		L2 Shade-leaves		ε ₀	
	Mean pE	Range	Mean pE	Range	Mean	Range
Summer	1.45	0.39 - 3.32	0.84	0.20 - 2.11	0.95375	0.0672 - 0.1107

Bleaching Indices for Indian Coral Reef Regions

Mass Coral Bleaching (MCB) events have been considered as a biological signal of climate change. MCB events are correlated with excursions of seawater temperature above the local summer maxima. Two bleaching indices (Bleaching Threshold and Positive Anomaly) for five Indian coral reef regions have been constructed based on sixty-three years' (1950-2012) historical SST data i.e. HadISST1 available at 1 degree spatial resolution. Bleaching Threshold (BT) is defined as the SST condition exceeding the climatological mean temperature of the climatologically Warmest Month (WM). Positive SST Anomalies (PA) for the climatologically Warmest Months for the Indian reef regions represent the absolute difference between the observed monthly SST and the Long Term Mean (LTM). The years corresponding to Very High, High and Moderate PAs recorded for the Indian regions were compared with the past global or regional MCB records.

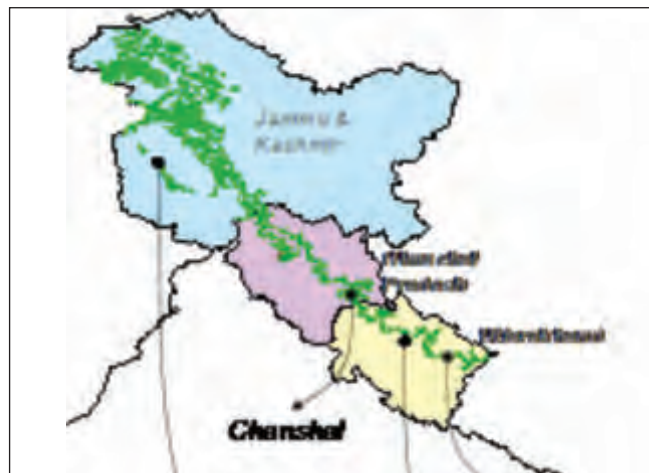
Runoff modeling and trend analysis over main land of India

- There is reduction in rainfall based runoff water availability (14.3%) during 1951-1980 period to 1971-2005 whereas significant increase (18.4%) has been observed for future projections over India (Fig.).
- Western and south-eastern region runoff show increasing trend for future scenario.
- Most of the river basins except Ganga and Cauvery show increase in runoff for future predictions.



Climate Change Studies in Alpine Ecosystem

Satellite based studies carried out at SAC have indicated substantial shift of alpine treeline in past three decades. For more conclusive results, a network of observations known as, 'Himalayan Alpine Dynamics Research Initiative (HIMADRI)' has been established (during 2014-2015) in five Himalayan states of India namely Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh. This network is based on multi-summit approach to capture the impact of warming through its baseline data on species richness, species composition, species migration, vegetation cover and hourly soil temperature records. Lichenometric analysis being conducted is helping us in understanding the past (500 years) changes at the key alpine ecosystem locations.



HIMADRI site locations in Indian Himalaya (Alpine treeline ecotone in green line as mapped using Resourcesat-1 LISS-III data)

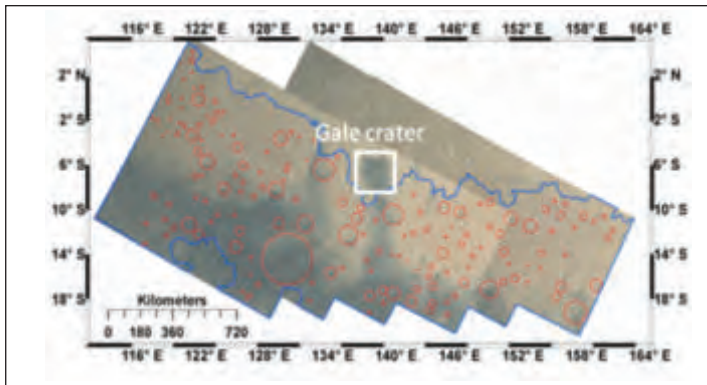
NISAR Science Plan:

Detailed science plan and observational requirements for NISAR dual-frequency SAR have been prepared. The first NISAR science workshop was organized at Space Applications Centre (ISRO), Ahmedabad during 17-18 November 2014 with the primary objectives of informing and involving Indian scientific community about NISAR mission; exploring new applications of dual-frequency SAR data; and searching for collaborative opportunities in SAR applications. The NISAR science workshop invited from the

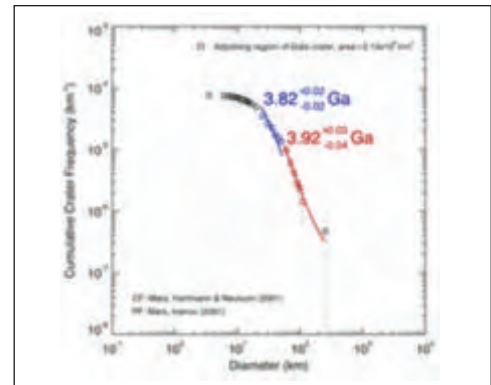
participants, new ideas and innovations on SAR applications for societal benefit. Several interested participants showed novel applications and innovative techniques for SAR data utilization through short presentations.

Planetary Sciences and Applications

Surface Age determination around Gale Crater over mars using MCC data of MOM: Study of impact craters provides the basis for determining the ages of martian surface. In the present study the determination of age of Gale crater has been carried out by using Mars Orbiter Mission-Mars Colour Camera (MOM-MCC) datasets. The goal of the present study is to find the age of the Gale Crater and surrounding area (figure 1) with the help of Crater Size Frequency Distribution (CSFD) technique (figure 2). Gale crater on Mars is around 154km diameter. It is located at 50S, 1380 E in Aeolis Planum region on Mars. This crater has been named after Walter F Gale, an astronomer who observed Mars in late nineteenth century. This crater is the landing site of Curiosity rover of Mars Science Laboratory mission of NASA. CSFD technique was used on MOM-MCC datasets to identify the age of the surface in and around Gale Crater. Study regions such as Gale crater, part of Terra Cimmeria (south of Gale crater) and Aeolis Mensae are considered for surface age estimation. Boundary of the geological unit is adopted from recently published global geological map, as geological boundaries. The mosaic of eight images was prepared at spatial resolution 450m as an input image for CSFD techniques. The results of this technique showed that the geological units in this region belongs to 3.82, 3.92 Ga (Noachian time). This results match with published maps of gale crater belongs to Noachian epoch. Noachian highland unit are the oldest surfaces of Mars (4.5 to 3.5 billion year).

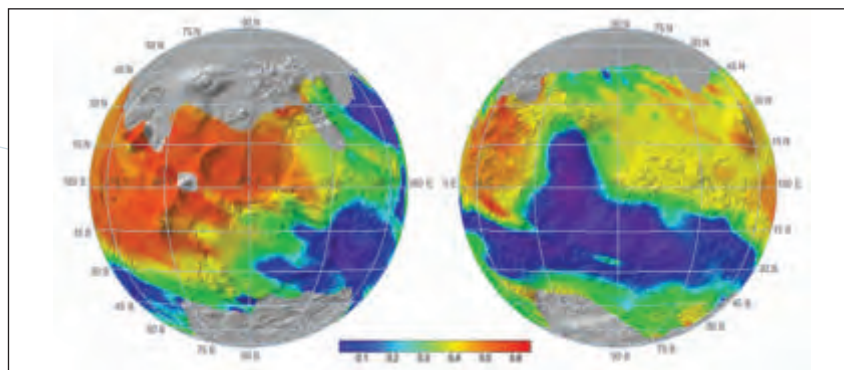


Location of Gale crater, Mars on mosaic of MOM-MCC data (at patial resolution 450m).



Crater Size Frequency Distribution (CSFD) technique around Gale Crater shows the geological units in this region belongs to 3.82, 3.92 Ga (Noachian time).

Global Albedo Mapping of Mars using MSM data from Mars Orbiter Mission: The albedo of the surface is defined as the fraction of incident solar radiation reflected by the surface. The magnitude and spatial

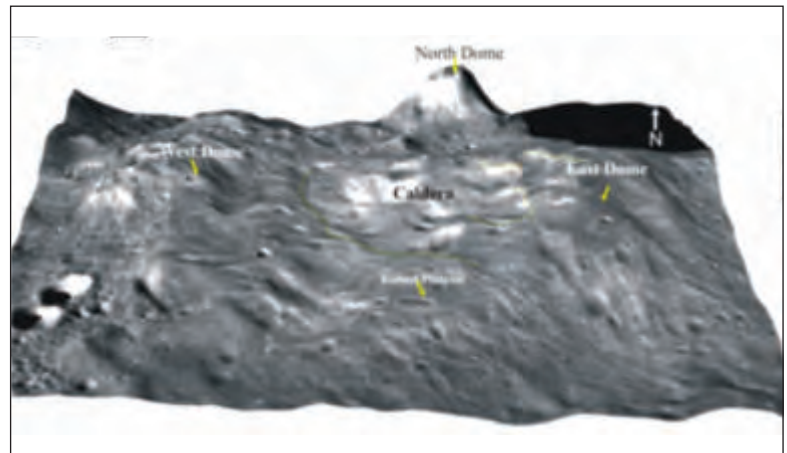


The 1 pixel per degree binned global MSM SWIR (1.65µm) albedo map.

distribution of martian surface albedo are important inputs for characterization of martian surface and meteorological system. Global SWIR (1.64-1.66 μm) albedo map of Mars derived using Mars Orbiter Mission -Methane Sensor for Mars (MOM-MSM) datasets. The MSM SWIR channel radiance data are converted to top of atmosphere reflectance; these values represent the albedo map of martian surface. Figure 3 shows the global view of MSM derived Martian SWIR albedo map at 1 pixel per degree spatial resolution. The bright regions (albedo greater than 0.4) are mainly localized over the Tharsis plateau, Arbia Terra and Elysium Planitia. The low albedo regions (less than 0.15) are mainly localized in Syrtis Major and Southern highlands, although low albedo regions such as Acidalia (less than 0.17) are also identified in Northern hemisphere.

Lunar Science using Chandrayaan-1 Data

Compton-Belkovich Volcanic Complex (CBVC): An ash flow caldera on the Moon : Compton-Belkovich Volcanic Complex (CBVC) (60.5 $^{\circ}$ N-99.5 $^{\circ}$ E) on the far side of the Moon is a unique non-mare silicic feature associated with endogenic/magmatic water. High-resolution remote sensing observations detected the presence of several structural features such as ring faults, radial faults, fractures, domes of varied sizes and shapes and pyroclastic ash flows. These features characterize it to be volcanic caldera, a rare but unique volcanic structures in the Solar System and analogous to the silicic calderas on Earth. Presence of late-stage fine pyroclastic layer at CBVC region is supported by radar-based Mini-RF observations and thus, it resembles an ash flow caldera on the Moon. This is the first report of an ash flow caldera on the Moon. The diverse volcanic features that exist at the studied site indicate a series of deformation and eruption events associated with silicic magmatism. Besides, the detailed study of morphological and structural features, present study has proposed an evolutionary model of the area and discussed the petrological implications of silicic magmatic activity, its manifestation, evolution and association with endogenic/magmatic water in the area.



3-D surface view of CBVC area in full resolution derived from LROC-NAC image of the area draped over the LOLA Digital Elevation Model (DEM) with a vertical exaggeration of seven.

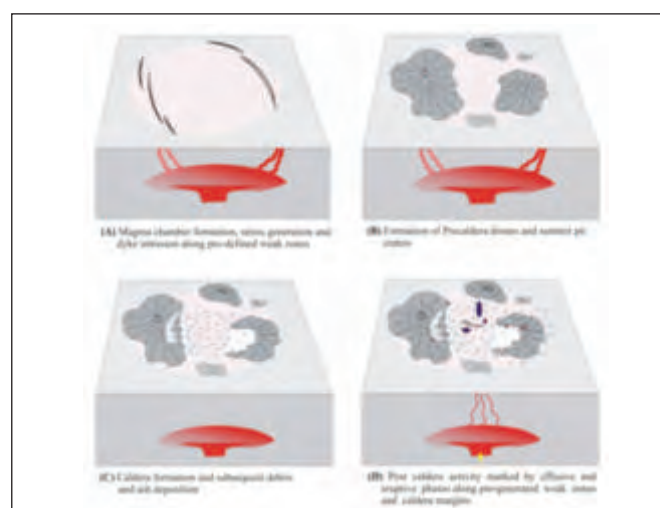


Figure 5: Schematic diagram showing the various stages of evolution of Compton-Belkovich Volcanic Complex.

Detection of magmatic water in association with olivine of possible mantle origin on the Moon: Using Chandrayaan-I Moon Mineralogy Mapper data (M3) data presence of enhanced hydration feature associated with the spectra of mineral olivine occurring with olivine-bearing lithologies have been reported from the Moon. The detected hydroxyl anomaly is associated with central peaks and crater rims of various complex craters and large impact basins of the Moon. Among them Mare Moscovience lies on the far side of the Moon while the rest occurs on the near side are Crater Aristoteles, Copernicus, Theophilus, Aristarchus and Sinus Iridum. The spectra collected and analyzed from these study areas show a characteristic composite band of olivine near 1020-1050 nm followed by a sharp hydration feature at around 2800 nm. The band strength of the hydration feature associated with olivine ranges on an average from ~4-6%. Most of the olivines in these study areas are characterized by the complete absence of a 2000-nm pyroxene and/or spinel feature except for those from Aristoteles, Copernicus and Mare Moscovience. The olivine at Sinus Iridium and Mare Moscovience occurs in association with orthopyroxene and Mg-spinel characterizing a lower crust or mantle lithology (OOS) with the exposures mostly confined to the inner ring of the basin. The olivine exposures at the other complex craters, namely Aristoteles, Theophilus, Aristarchus and Copernicus are dunitic/troctolitic in nature. The associated hydration feature is suggestive of a possible deeper magmatic source as indicated by the unique tectonic settings of these complex craters, their relatively young age and associated thin crust. The present study has important implications for understanding the relation between the olivine and the associated hydrous feature in the remotely sensed spectra, which in turn will help in understanding the hydrous nature of lunar mantle and the heterogeneous distribution of endogenic water in the deep lunar interior.

Mapping of olivine rich layer in Mare Nectaris : The craters present across the Nectaris basin has been studied based on their reflectance spectra to map the extent of olivine rich layer. The mapped olivine rich sites may represent exposures of the lunar mantle or differentiated plutons resulting from secondary magmatic intrusions into the lunar crust. The olivine rich layer in the Nectaris basin has been mapped that may represent compositional distinct flows present within the Nectaris basalts which have not mentioned in earlier studies.

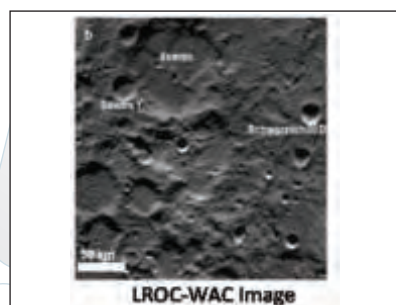
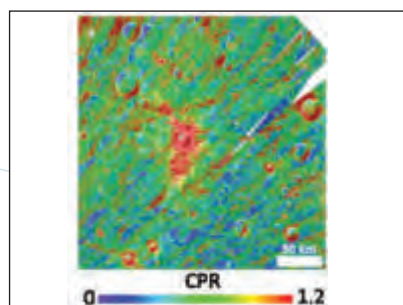
Chandrayaan-1 Mini-SAR Data Analysis

This project has been initiated with the objective "Modeling the scattering properties and its relation with lunar surface using Mini-SAR data in conjunction with other lunar data".

Achievements:

- Developed & implemented a methodology to synthesize Hybrid-Polarimetric signature from Stoke's vector of Mini-SAR data over lunar regolith
- Hybrid-Polarimetric signature has shown significant physical relation and correlation with volume fraction of Rock abundance in lunar surface.

Development of Surface Roughness Map:



Circular Polarization Ratio (CPR) image overlaid on Mini-SAR total backscatter image of a part of lunar north polar region indicating regions of rough surface.

Chandrayaan-2 Dual-Frequency SAR-Science Plan

This project has been initiated with the objective "Modeling & Simulation of Lunar Scattering behavior and Development of Multi-frequency Index Planetary Ice detection"

Achievements:

- Developed a Multi-layer scattering model (IEM) for lunar regolith surface to provide quantitative relationship between radar backscatter and the physical properties of the lunar regolith layer at L- and S-band for different incident angles (figure-1).
- Developed a novel index for Lunar Polar ice Detection (LPDI) based on dual-frequency radar backscatter at L- & S-band.
- LPDI has been simulated based on different buried ice and rock concentrations (2% -6%), which clearly shows a distinguishable difference between buried ice and rock characteristics. LPDI predicts large differences for higher rock concentrations (figure-2). This index will be very useful for identifying and characterizing lunar polar-ice using Chandrayaan-2 dual-frequency SAR data.

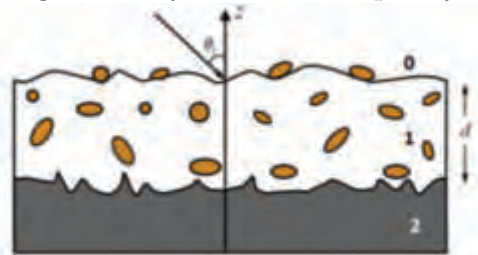


Figure 1 Schematic diagram of the lunar surface that consists of a regolith, rocks and ice inclusions, and underlying bedrock

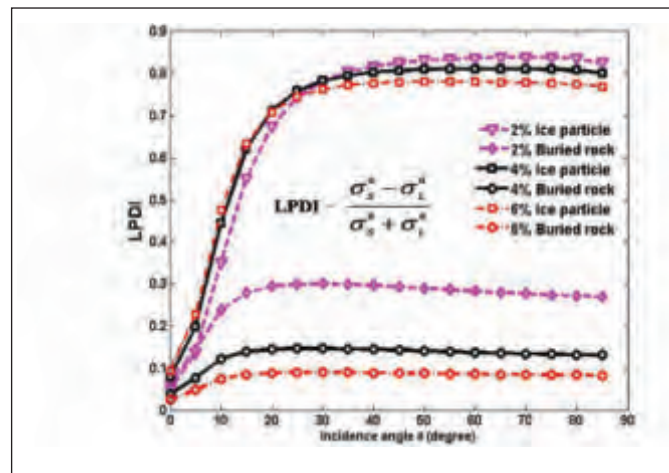


Figure 2 Lunar Polar ice Detection Index (LPDI) as a function of incidence

Desertification Status Mapping of India

Preparation of Desertification/land degradation Status Maps of entire country at 1:500,000 scale using AWiFS images of 2011-13 & 2003-05 time frames in GIS environment have been completed. Figure 1 shows Desertification/Land Degradation Map of Maharashtra prepared using AWiFS data of 2011-13 time frame on 1:500,000.

Quality Checking (QC) of Desertification Status Maps prepared using satellite data of 2011-13 time frame in GIS environment for 27 states (Arunachal Pradesh, Andhra Pradesh - including Telangana, Assam, Bihar, Delhi, Goa, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Karnataka, Maharashtra, Meghalaya, Odisha, Punjab, Uttar Pradesh, Uttarakhand, West Bengal, Mizoram, Tripura, Rajasthan, Madhya Pradesh, Manipur, Nagaland, Sikkim, Chhatisgarh and Haryana) and Union Territory of Andaman & Nicobar has been completed. QC for remaining three states (Gujarat, Kerala and Tamilnadu) is near completion.

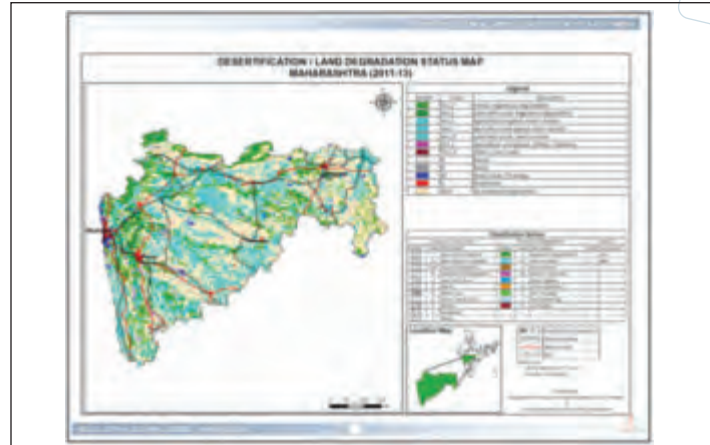


Figure 1: Desertification/Land Degradation Map of Maharashtra prepared using AWiFS data of 2011-13 time frame on 1:500, 000

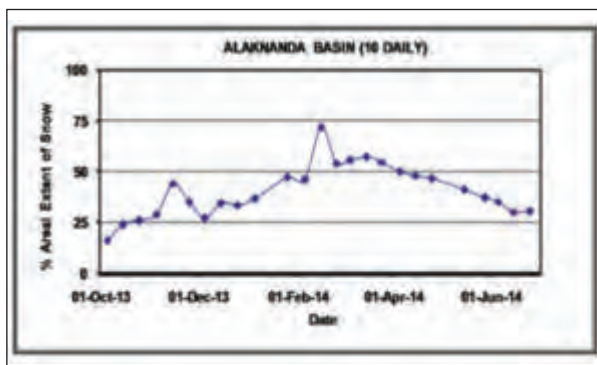
Monitoring Snow and Glaciers of Himalayan Region (Phase-II)

100% target has been achieved for identified RFD elements for the year 2014-15 related to the project. These are “10 daily Snow Cover maps for 30 sub-basins for October 2013-June 2014” and “Glacier Mass Balance estimation for 10 sub-basins for the year 2013”.

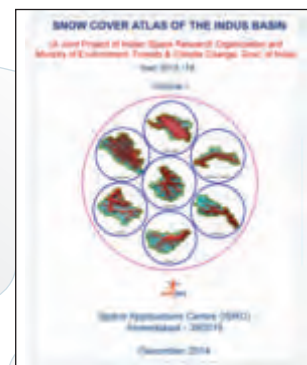
The project has been completed and a consolidated report is under preparation. Highlights of major achievements during the year 2014-15 are as follows:



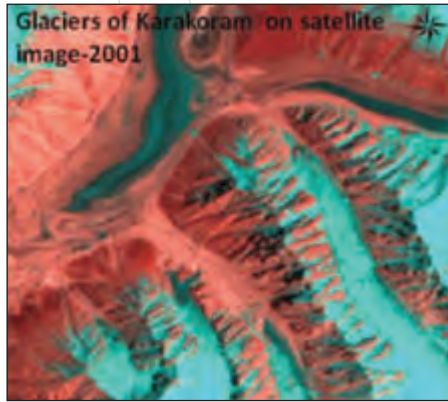
Snow cover products for the year 2013-14 for the Alaknanda sub-basin



Accumulation and ablation pattern of snow cover over hydrological year 2013-14 for the Alaknanda sub-basin



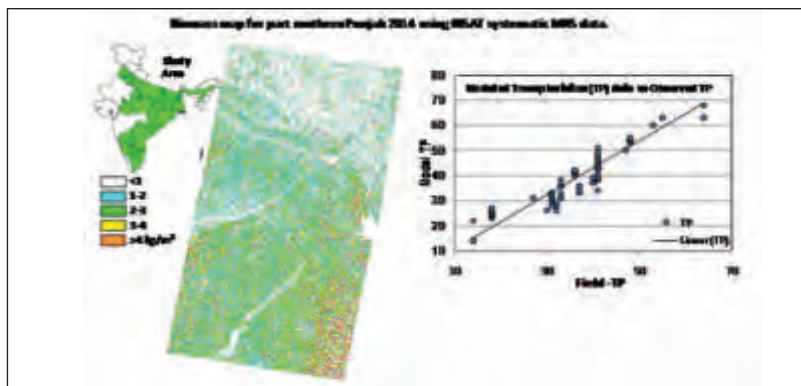
Snow cover Atlas of the Indus basin for the hydrological year 2013-14.



Two advancing glaciers in Karakoram region are seen distinctly on satellite images of 2001-2010

FASAL (Forecasting Agricultural output using Space, Agro- meteorology and Land based observations) R&D

During the year 2014-15 the production estimation of three crops viz., sugarcane, cotton and rabi sorghum were operationalised to MNCFC. The technique of rabi pulses estimation was tested on large scale using multivariate AWiFS data for six states viz., Madhya Pradesh, Andhra Pradesh, Uttar Pradesh, Karnataka, Rajasthan and Maharashtra covering 80.03% of Rabi pulses area and 80.23% of Rabi pulses production of India. National Rabi Pulses area estimate for Rabi season 2014-15 was 8.963 M ha which include were gram, lentil, peas, green gram, redgram, blackgram and miscellaneous pulses. Pulses. The RISAT based rice yield models developed at SAC were used in the operational F3 forecast of MNCFC.



RISAT based biomass output used in rice yield model for F3 forecast of MNCFC

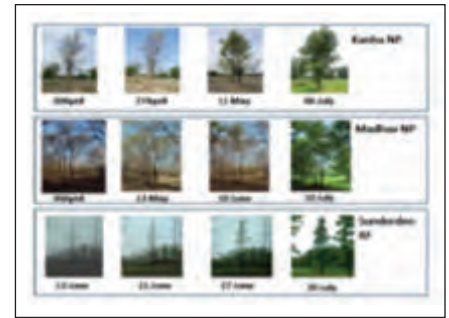
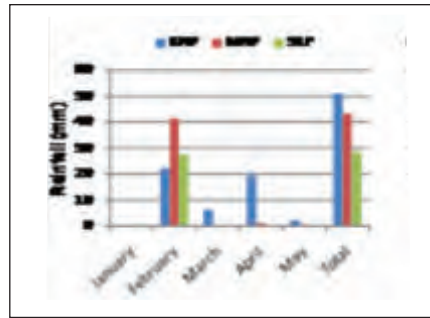
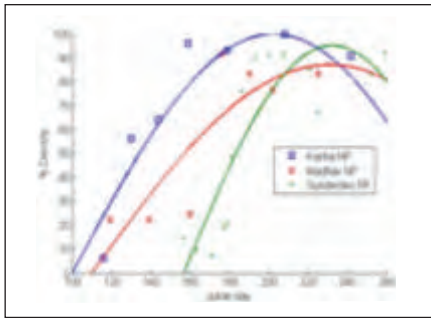
Similarly mustard yield models were developed using AWiFS and collateral data at SAC and were used in final forecast of MNCFC. The semi-physical spectral-spatial wheat yield model developed at SAC was run at MNCFC by SAC scientists and training was given to MNCFC personnel for running the model and deriving planting date from time series NDVI data. MNCFC used the yield outputs for giving final production forecast on 10th April 2015.

ISRO GBP: Energy and Mass Exchange in Vegetative Systems

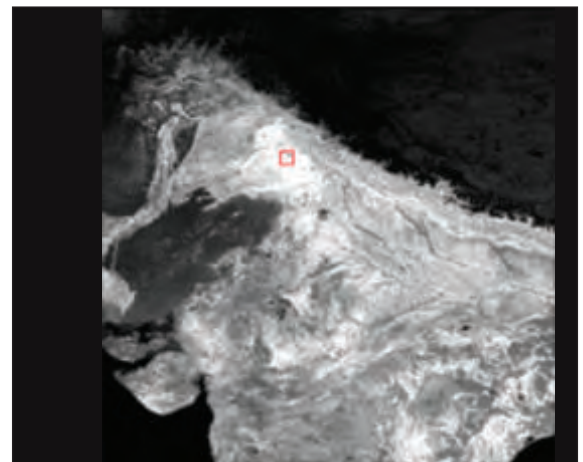
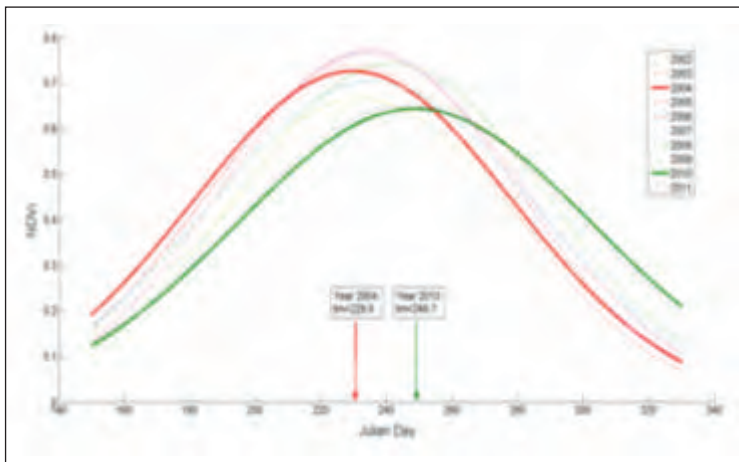
Climate change and land surface evapotranspiration (ET): Evapotranspiration (ET) is one of the important components of water cycle. It contributes about 40-60% for water loss against its input through rainwater and irrigation. A network of 22 INSAT-linked micro-meteorological stations (popularly known as Agro-Met Station, AMS) has been established over 15 agro-climatic regions in the country to characterize radiation, energy and water fluxes over different vegetation systems. The measurements from AMS network were used to develop linear and non-linear scaling functions for longwave radiation and soil heat fluxes, and bias correction function for reanalysis product of incident shortwave fluxes on monthly scale.

Phenological Studies

- Forest Phenology :** Forest Phenological observations at multiple locations using weekly digital photographs indicated trend in spatial phenology of same species (Palash- *Butea monosperma*) at multiple sites. It clearly indicated green-up onset in Kanha NP earlier than MADhav NP and Sunderdeo RF. Rainfall trend at selected locations were analysed indicating that higher rainfall at Kanha national park, that is possibly leading to earlier greening in every season, followed by Madhav national park and Sunderdeo reserved forest. The observations are based on 4 years of photographic data from 2010 till 2014.



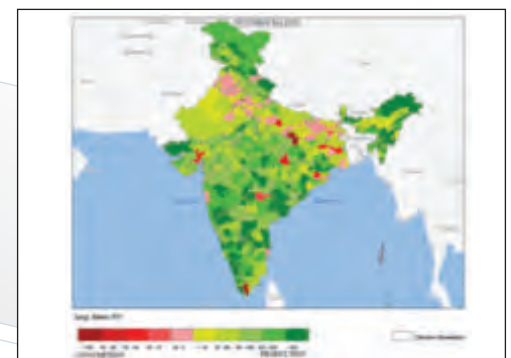
Crop Phenology : Shifting pattern of rice cultivation was detected in Punjab, India using SPOT-VGT 10 day composite NDVI data and analysis showed that the practice of pre-monsoon irrigation is slowly being abandoned. This has caused a shift (advance) of almost 3 weeks in the peak growth time of rice crop over the study region. The following image shows the rice crop phenology over the period 2002-2011.



Detection of shift in rice crop phenology over the study region shown in red box.

Terrestrial Energy and Mass Exchange

The research work is being carried out under 'Energy and Mass Exchange in vegetative Systems' project of ISRO-GBP. Major research highlights include estimation of All-India district level Rural, Urban and Net Energy Balance for the years 2001/2011, Spatio-temporal analysis and correlation of Particulate Matter and Aerosol Optical Depth over Ahmedabad using field and satellite data; and analysis of recent observations of Orbiting Carbon Observatory (OCO-2) data and long-term CARBONTRACKER_CT2013B data for understanding current and long-term trend of atmospheric CO₂ concentrations over India.



All-India District level Energy Balance for the year 2001

MOSDAC (Meteorological and Oceanographic Satellite Data Archival Centre)

Android Weather App: MOSDAC Weather Application has been developed and released for ANDROID platform that provides: 3 hourly weather forecast for next 72 hours, Location based NOWCAST Alerts/Notifications related to Heavy rain / Cloud burst(half hourly forecast) for Uttarakhand, Himachal Pradesh and surroundings.

CEOS Catalogue: Integrating MOSDAC data to CEOS Integrated Catalogue system: MOSDAC has been able to integrate its Catalogue with CEOS-CWIC, making ISRO an operational CWIC (CEOS WGISS Integrated Catalog) partner. This has enabled searching of MOSDAC data products using global web interface of CEOS.

AOI based Products Search and Ordering: AOI selection module has been released over MOSDAC that aids users in selecting a bound box of their choice. AOI based product ordering is offered for SARAL and MEGHA-TROPIQUES data products which cover the entire globe.

Web GIS based development:

- GeoServer based value addition to Heavy Rainfall and/or Cloudburst alerts over Uttarakhand and Himachal Pradesh made operational.
- Web-GIS based application for Heavy Rain all over India is released on MOSDAC website.
- Current position of SARAL and MEGHA-TROPIQUES satellites with update at every 10 seconds is hosted on MOSDAC Home Page.

Disseminating Science Products: Science Products disseminated via MOSDAC that includes Sea Ice Occurrence Probability based on 34 and 36 years data prepared from NSIDC sea ice concentration (SIC) data over the Antarctic Region and Inland Water height of rivers and reservoirs using SARAL data.

CYCLONE (SCORPIO) : SCORPIO site was updated in near real-time for NANAUK, NILOFAR and HUDHUD cyclone in Indian Ocean . The near real time imagery of INSAT-3D, MT, track , intensity and storm surge forecast for all the cyclones were updated on the site.

Sea State Forecast: (1) End to end automation for execution of Ocean circulation model and Wave model and current generation with email based notification and operationalization of Ocean circulation model output on MOSDAC. (2) Sea State forecast (POM, WAM, and SWAN) output is also provided to NIOT for their buoy operation through automated procedure.

MeghaTropiques: Level-2 Data reprocessed using update software version 7 and products are released. Megha-Tropiques ISSDC-MOSDAC data transfer link switched over to NKN.

SARAL: GDR Generation software upgraded to version SPAv4.3P1 and GDRs are generated for cycles 13 to 21.

Near Real Time Data Dissemination to International Users:

Automatic software developed for providing Near Real Time INSAT-3D data to SSEC-Wisconsin University, EUMETCAST, DMSP-NRSC, SHAR, INMAC Kochi over FTP.

Near Real time data availability of Eumetcast data over High speed network (NKN) to NCMRWF

WRF Weather Forecast: 3 Hourly weather forecast output made operational on MOSDAC.

Data Downloading Crawler:

- Web Crawler based software package for integrating all GFS forecasts required for the generation of various INSAT3D products has been developed and operational at IMD, Delhi and MOSDAC-INSAT3D

Data Processing setup.

- Automatic web crawler operational at MOSDAC for downloading and archiving RAPIDSCAT data which is used for updating any Cyclogenesis over Indian Ocean

Web-based Monitoring: Developed and operationalised a facility for real time Web based monitoring of dB levels from Radyne Modem DMD20 on MOSDAC intranet. Major monitoring operations, including checking of EUMETCAST data reception, dB status of KALPANA, INSAT-3D Imager and Sounder, carried out in MDRS lab have been shifted to MOSDAC operations Lab by using Network based techniques to display the device based digital output on computer system at operations Lab.

INSAT-3D Data Utility: A software utility for the INSAT-3D data channel extraction is released on MOSDAC

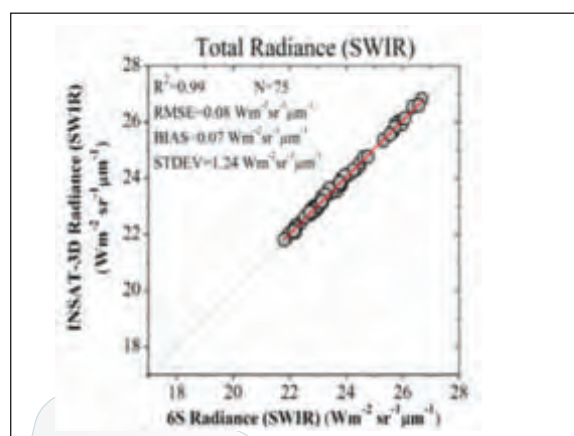
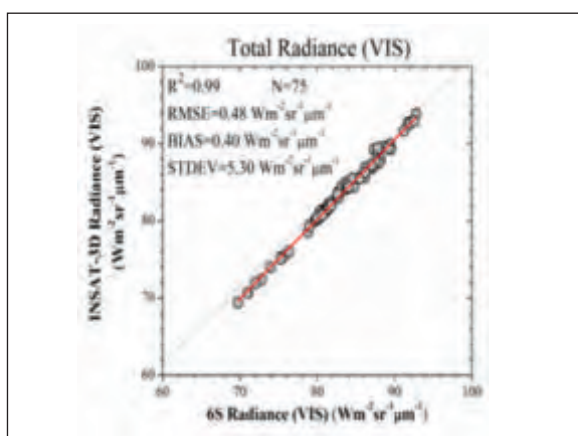
MOSDAC FTP Server Bandwidth Augmentation: MOSDAC servers used for data dissemination to users have been upgraded to 50Mbps network bandwidth through NKN.

Version Control Software: Software Version Control tool is a web based application that is aimed at maintaining information about all versions of the software codes developed at MOSDAC. It also maintains an archival of software codes. This code is made operational.

AWS: CAMC of AWS is under progress

Calibration and Validation Activities

Calibration of INSAT-3D visible and SWIR channels: Vicarious calibration of INSAT-3D VIS and SWIR channels was carried out during February-March, 2015 at Little Rann of Kutch indicating satisfactory onboard performance of these channels with respect to simultaneous ground measurements and radiative transfer simulations. Figures below shows the scatter plot between total radiance in visible SWIR band of Imager and corresponding theoretical radiance based on ground measurements and radiative transfer simulations for five different observation days (20 Feb 2015 to 20 March 2015).



Aerosol trend over Kavaratti: The aerosol optical depth indicates the opacity of the atmosphere in altering the Earth's radiative budget. This highly variable parameter is being measured using CIMEL robotic sun-photometer at Kavaratti since 2009. The AOD values are changing periodically rising upto pre monsoon period (April end) with higher loading in winter season. The source of higher AOD is due to the mineral dust transport from Arabian countries, Indian sub-continent and locally generated marine aerosols. Since the winds are weak over this site in winter season as compared to southwest monsoon, the transported particles in the atmosphere influences the optical properties very much.

Absolute Calibration of SARAL/AltiKa Sea surface height: The Kavaratti calibration site has non-contact radar tide gauge for sea level measurements which is used for carrying out absolute calibration of SARAL/AltiKa sea surface height. The pass #539 of SARAL passes over this Island. 17 cycles of SARAL/AltiKa derived sea surface height is used for computing the absolute calibration bias at this site. The determination of absolute bias between the SSH derived from the radar altimeter and the tide gauge (in-situ) at the comparison point is done by bringing the level of each measurements to the same coordinate reference frame (altimeter). The 17 cycles of SARAL/AltiKa shows a mean SSH bias of -38.323.8mm which is within the mission requirement (46 mm). Figure 3 shows the time series of absolute SSH bias for 17 cycles of SARAL/AltiKa with respect to radar tide gauge at Kavaratti site.

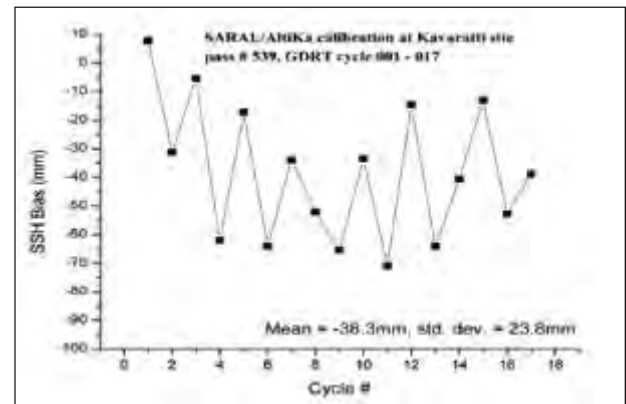


Figure 3: SARAL/AltiKa SSH bias from cycle 1 to 17 using GDR-T products.

Calibration of RISAT-1 Fine Resolution (FRS-1) and Medium Resolution (MRS) Mode data: Radiometric calibration of RISAT-1 FRS-1 and MRS beam mode data was carried out during July 2012- January 2014. For MRS mode, calibration constant has been computed by deploying corner reflectors and studying its Impulse response for 6 (six) dates for HH polarisation image over Ahmedabad, Jodhpur and Desalpar sites in India. For FRS-1 mode, calibration constant has been computed by deploying corner reflectors and studying its Impulse response for 17 (seventeen) dates for CH, CV, HH and VV polarisation image. Data quality parameters have also been computed using the point target IRF. Figure 4 shows a typical Impulse response function of point target for RISAT-1 MRS mode HH polarization on 01 January 2014 at Cal-Val site.

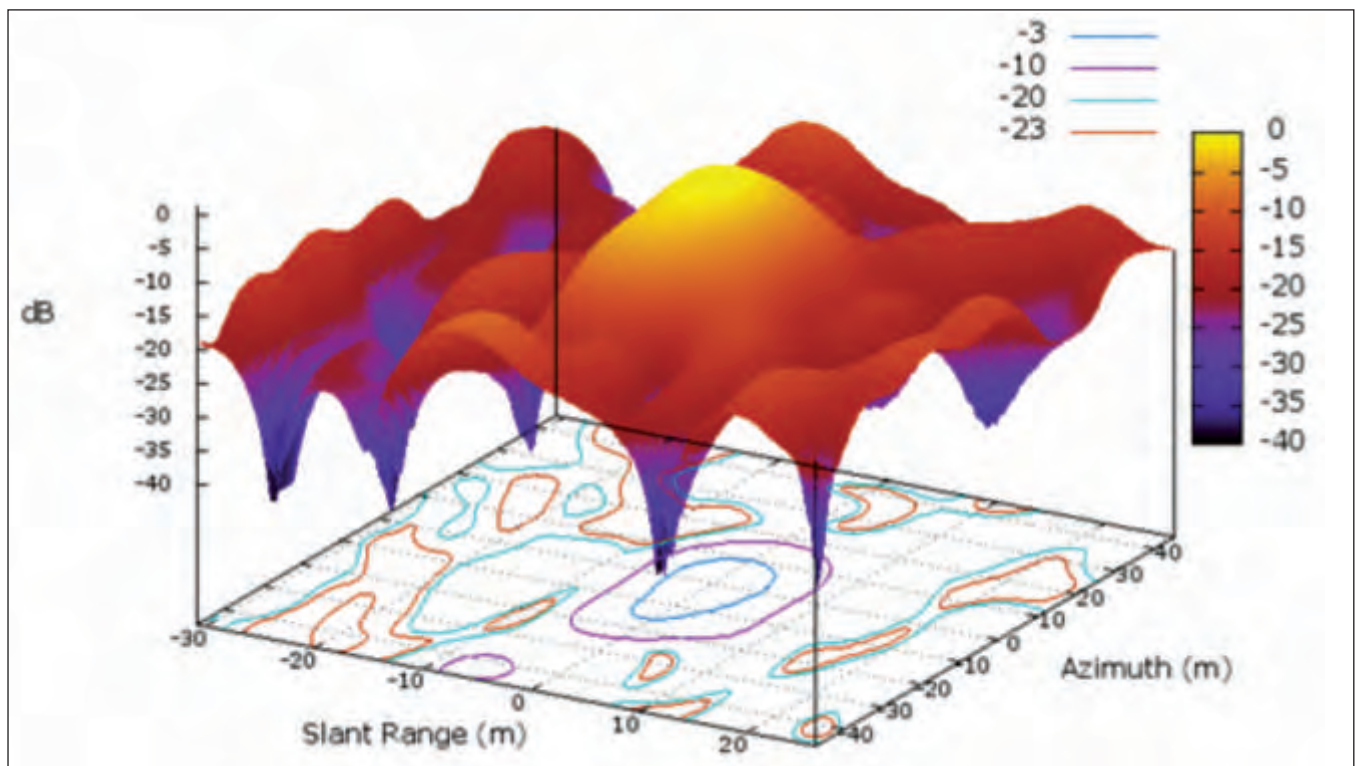


Figure 4: Impulse response Function for MRS mode HH polarisation for point target (01Jan2014)

Establishment and Operationalization of SAC-Bopal, Ahmedabad Cal-Val Site for high resolution optical and SAR sensors: The SAC-Bopal site in Ahmedabad has been developed for vicarious calibration of high resolution optical and SAR sensors. This site has been artificially created in the newly acquired land by SAC adjacent to Bopal campus (Figure5 & 6). This site is very useful for high resolution sensors like CARTOSAT-1 & 2, IKONOS, LISS-4, RISAT-1/SAR (FRS and MRS mode).



Figure5: SAC-Bopal cal-val site along with its location on the Google Earth

Facilities

During the year a large number of facilities have been brought-up to cater to the future demands of the payload developments in the Centre. New technologies/process development activities in the areas of antenna, Electronic & Mechanical Services & Support have been taken up to cater the need of future payloads requirements.

LTCC facility was established and qualified. Some of the important facilities realized are

- E-beam evaporation system for thin film metallization
- Multi Layer Press for MLB facility
- Multiple parameters environmental test system
- Refurbished Salt Spray Chamber as per ASTM B117

In-house 13 new process are qualified and 10 new are under progress

- Qualified 9 variants of PTFE laminates for PCB fabrication.
- Qualified Cr-Cu-Au metallization on Alumina substrates for MIC fabrication.
- Qualified MMIC Package Solder Sealing under inert environment utilizing Hot gas reflow.
- Qualified immersion Black Coating on Aluminum alloy 6061T6.
- Qualified galvanic Anodizing on Magnesium alloy AZ31B

Following units are delivered during the year

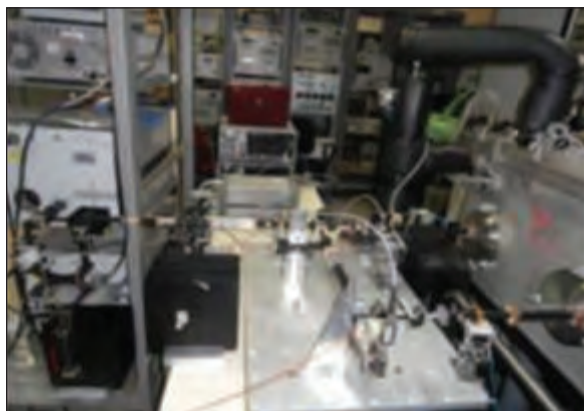
- Delivered 4040 MICs, 64 Masks, 40 SAW devices, 17 Calibration targets, 5465 Bare PCBs, 240 Flexible PCBs, 874 Wired PCBs, 69 Packages.
- Carried out 75865 Hrs and 20689 Hrs of environmental testing in Climatic and Thermovac chambers respectively.
- Carried out 32.40X105 cm² and 8.88 X105 cm² area of Surface treatment and Thermal painting respectively.
- Carried out calibration of 317 equipments, incoming inspection of 111 equipments and repairing 198 equipments instruments/equipments.

Some of the important activities carried out during the year are:

- Qualified M/s UHV Inc, USA for Cr-Cu-Au metallization on 25 mil Alumina substrate, Size=1"X1", metallization thickness= 5 to 7 μ m & uniformity= \pm 10%.
- Qualification of M/s Hi-Q Electronics for 10 layer MLB with 0.2 via filled with epoxy & selected solder mask and Rigid-flex boards is under progress
- Implementation of Finger print based Biometric Access Control System is under progress.
- Realization of Large Thermovac 6.5M diameter at Bopal camps is in progress and PO to be released shortly. NIT for building is being issued.
- Completed NABL re-certification with enhanced capabilities.
- Carried out integrated panel level test for IRNSS 1C & 1D.
- Management policy for Vendor Complex at Bopal Campus is approved by ISRO, Chairman/ Secretary, DOS and technically cleared by subcommittee constituted by CWRC
- Highly Accelerated Thermal Shock test: Conducted first time as per IPC-9151D on 10 layer MLB coupons having 0.2 mm via filled with epoxy and Selective solder mask.

Facility Augmentation

- Establishment of Ka-Band Ring Resonator, Ku-Band Ring Resonator & Ku-band multi-chain high power test setups around two thermo vacuum chambers.
- Establishment of Ka-band and Ku-Band PIMP measurement test set-up.
- Column drilling machine
- 20 ton shaker along with 96 ch.control system



GSAT-11: Ka-Band Ring Resonator Test set-up



GSAT-11: Ka-Band PIMP Test Set-up



20 ton shaker

Network & Information Services

Information Technology and network services in SAC is maintaining all centralized network services within the Centre. It provides operational services for web applications like SAC intranet - Aakash, SAC Website - Vyom, digital repository - Vedansh, Transport booking, resource booking etc. In Vedansh report generation is implemented and released to highlight repository-wise Retired, Transferred and Retiring Employees in Vedansh T and Vedansh NT. It provides all technical services and support for the online antivirus application, email, FTP, security and internet services within the Centre.

Reliability & Quality Assurance

Standard engineering practices and necessary screening & test facilities have been established to assure reliability and other qualities of all systems developed at SAC. This include (i) payload and ground HW systems; (ii) HW systems with embedded SW for space or ground use; or (iii) SW-intensive systems and services, for ground applications.

Reliability and Quality Assurance for HW Systems:

- HW systems are realised using electronics, micro-electronics, electro-optical and mechanical components with electro-chemical coatings; either entirely using in-house fabrication and test facilities; or outsourced from qualified vendors, with following R & QA efforts:
 - Selecting suitable parts and components, careful screening, storage and handling in controlled clean-room environment.
 - Adopting a development cycle involving distinct models for fabrication, integration and qualification.
 - Conducting peer-reviews throughout realisation life-cycle starting from specifications to design to fabrication of parts and subsystems and subjecting them to rigorous cycles of test and evaluation.
 - Characterization of integrated payloads, simulating spacecraft interface as closely as possible.
- Establishment and practice of Standards for all the above activities, throughout the entire HW realisation life-cycle.
- Life-tests, reliability estimation, failure analyses are some of the other activities that help in realising payloads with enhanced reliability and quality characteristics.

Reliability and Quality Assurance for SW Systems:

- Ensuring implementation of ISRO software process standard in the Centre.
- Participating in SW reviews, static/ dynamic code analyses, verification & validation activities, and audits from the beginning of SW development projects.
- Hosting a tool-suite including web portals for serving QA assets, project portals and reuse promotion.
- Collecting and analysing SW metrics; conducting trainings on standards, tools, quality practices and generation of document-templates; and performing analyses for assessing root cause of failures, towards process improvement.

Payloads Covered:

R & QA activities were carried out for payloads of ongoing and future projects:

- 8 (GSAT) Communication payloads (including applicable ground applications SW)
- 3 Navigation (IRNSS) payloads (including ground applications HW and SW)
- 8 Optical RS (GISAT, Resourcesat-2A, Cartosat-2C/D, INSAT-3DR/3DS, Chandrayaan-2, Aditya, Astrosat, Microsat) payloads, and
- 5 Microwave RS (RISAT-3, Scatsat-1, mm-Wave TSU, NISAR, Oceansat-3) payloads.

Quality Assurance for HW Components, Processes and Material: Component Level Quality Assurance

- QA support provided for procuring components including: MMIC (Die and packaged) devices, RF-switches, Isolators, Circulators, TCXOs & OCXOs, Mixers, Power Dividers, Filters, GaAs & GaN RF transistors, etc.

- Test data review revealed that for a particular type of connector, screening tests performed by vendor were incomplete, and the same was resolved at vendor's end.
- A packaging related issue was found during screening and was resolved by vendor.
- During the year about one lakh components were inspected and cleared.
- Destructive Physical Analysis was carried out for seven new device-types; and Construction analysis was carried out for Tri-colour LED.
- Cumulative Life testing of 1.25 lakh device hours for qualifying various types of components (Mixer MMIC die, microcircuits, etc.) was completed.
- Five cases of failures were simulated and analysed for the root cause.
- A program for characterisation of OnBoard Computer OBC-ASIC 1.1 on VLSI test system was developed and is under testing and debugging stage.
- Radiation testing and mitigation catered to shielding requirements for 15-year mission life of components for INSAT-3DR/3DS and EPCs for GeoSAT.



*Assembled mixer
MMIC in test box*



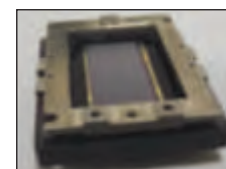
*Set-up for burn-in & life
test of MMIC Mixer*



*Bubble stream showing
gross leak*

Special Components' Quality Assurance

- During an assembly level qualification testing, an anomaly was observed in MX-detector-bonding and the same was analysed.
- New samples had undergone re-testing successfully.
- MX and PAN detectors for Carto-2C have successfully undergone assembly level qualification for direct bonding with mounts.



*MX Detector in
its mount*

- Screening and qualification of Rover Imager camera module for Chandrayaan-2 completed successfully including the -197°C storage test and UV exposure.



- Optical design reviews of FCO baffle, opto-mechanical design for LWIR auxiliary optics & FCO and stray light analysis for TIR channel for GISAT were carried out.
- Optical design and analysis of PAN and MX channels of Cartosat-3 series were reviewed.
- Light weighting analysis of primary mirror of Cartosat-3 was reviewed.
- While inspecting the primary, secondary and tertiary mirrors along with witness samples for LISS-IV of Resourcesat-2A, black speckle patterns with bluish background were observed on the entire surface of all three coated mirrors. Based on the photographs of the deviation and detailed technical discussion with LEOS experts, the mirrors were sent back to LEOS for investigation and corrective action. Recoated mirrors were found satisfactory during re-inspection at SAC.
- A SW was developed to monitor and control the atomic clock during thermo-vac test.

Bonded Stores

- This class-100,000 clean-room facility is available 24x7 for 365 days.
- Moisture-sensitive items like bare PCBs are stored under dry-nitrogen environment.
- A total of more than five lakh items were handled through a comprehensive SW access control, including corresponding test reports, as applicable.
- Stereo-microscopes with 100X magnification were installed for handling miniaturised components.

Process Level Quality Assurance

- Fourteen new processes were qualified involving fabrication and assembly using RF laminates and hermetic sealing of MMIC packages for GeoSAT programme.
- More than 300 PCB/MIC/HMC layouts were approved.
- A new 4-probe sheet resistance meter was procured and measurement facility established.
- The portable radiography system was upgraded.

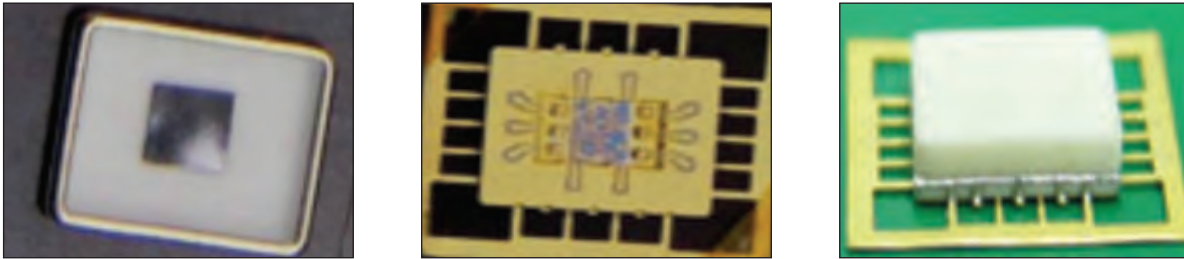


Figure: Mixer-MMIC Package Solder-Seal

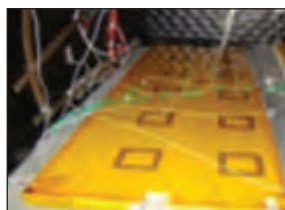
Note: Mixer-MMIC package hermetic sealing process by hot-gas solder reflow method was qualified and the package has passed a life test of 2000 hours.

Quality Assurance for Mechanical Parts, Materials & related Processes

- QA for mechanical parts, materials and related processes involved in space payloads include: material testing, fabrication, assembly and integration surveillance, audit and certification.
- Materials like Invar, Al, Rohacell, RTV, CC were tested for tensile strength, thermal expansion, total loss of mass (TML) and condensable volatile condensed mass (CVCM) specifications.
- Assembly-and-vibration surveillance was carried out for Feed, EO modules, electronics packages, north and south panels with tri-panel assembly.
- Handling and transportation surveillance was carried out for integrated payloads.
- Contamination control was exercised by particulate count measurements.
- About 25 plating and painting processes, such as Silver plating on Al, were re-qualified for space use.
- Al₂O₃-Invar bonding process using EC 2216 was qualified.
- Lot acceptance tests were completed for three-layer metalized substrates, such as Cr-Cu-Au.
- In-house generation of WR-75 waveguides involving bending & TIG welding processes was qualified.
- Direct Metal laser Sintered (DMLS)-Invar material fabrication process was qualified.
- Planer antenna fabrication facility was evaluated for Chandrayan-2.



Vib. Surveillance Ka Feed



PAAF Facility evaluation



WR-75 qualification



DMLS Invar material qualification

EMI/EMC tests

- EMI/EMC tests on approximately 400 subsystems of communication, remote sensing and navigation payloads were carried out.
- SRA team carried out extensive investigations and identified leaky/vulnerable locations for improvement in EMI performance of 62 subsystems.
- A new automated test setup for bulk cable injection tests (CS114, CS115 & CS116 as per MIL-STD-461E) has been installed.



Automated Test Set up for Bulk Cable Injection tests CS114, 115 & 116 as per MIL-STD-461E

- In addition to testing in-house developed payload subsystems, tests for vendor-developed subsystems were supported, towards qualifying a set of vendors for outsourcing development/testing of space-qualified HW subsystems.

Test and Evaluation Activities

- About 300 payload subsystems for communication, navigation and remote sensing payloads were T&Ed, and anomalies were identified in about 20.
- Extensive simulations were carried out to analyse and resolve these problems. Afterwards, all these units were re-tested successfully.
- Re-validation/ acceptance testing of about 200 procured subsystems like driver amplifiers, receivers, SSPAs & TWTAs was carried out.
- Integrated payload level T&Es for space payloads were carried out.
- SRA team also participated during spacecraft level testing, pre-launch phase testing and initial phase in-orbit testing.
- SRA team developed the following automated test set-ups to improve repeatability of tests and to reduce the time in making measurements.
 - Measurement of IRNSS modulator performance
 - HW and SW for TTC simulator for IRNSS modulator
 - Stimulus generation & measurement of Noise Power Ratio of high power amplifiers
 - Improved the automated filter characterization SW.

Reliability Engineering Activities

- Reliability-engineering and circuit-review activities were carried out through peer-review teams and standing circuit review committee, for GSAT-7A/9/11/15/16/17/18, IRNSS, CY-2, INSAT-3DR/S, GISAT, Astrosat, Cartosat-2C, Scatsat-1, and RISAT-2A projects.
- A study was carried out on failure rate prediction methodologies adopted by space agencies for complex, newer-technology COTS devices in order to overcome the limitations of MIL-HDBK-217F standard. Study concludes suggesting FIDES Guide as the most suitable standard for this purpose.

Indigenisation

- Resistor network components are now indigenously developed (previously imported from USA) at a vendor site as per SAC specifications. Qualification testing of the indigenously-developed component samples for two variants, have been successful.

Industry Development

- Five vendor facilities were audited and certified for MIC, MIC/PCB, HMC, and MMIC related outsourcing.
- Another vendor was qualified for developing waveguides including the associated bending & TIG welding processes. This will be useful in realizing welded waveguide assemblies in bulk for GSAT-11.

ISRO Reliability Standards

SRA team contributed significantly and lead the effort in generating the following two ISRO Reliability Standards:

- Contamination Control & Cleanliness Requirements, ISRO-PAS-400, Issue 1, Feb 2015
- Environmental Test Specifications for ISRO Spacecraft, ISRO-PAS-202 Rev 1, 2014

Onboard SW Quality Assurance

- SW QA activities were carried out for FPGA/ ASIC, and Micro-controller based SW for onboard and ground-checkout use.
- Verification of FPGAs of NSGU for IRNSS payloads, digital controller card of GSAT-15, TMC-2 of

Chandrayaan-2, various modules of an onboard computer (OBC-II) ASIC and Xilinx-IP core for sine-cosine LUT generation were carried out.

- SW QA for Onboard and Checkout SW of IRNSS, SCATSAT-1, INSAT 3DR, Carto-2C and ground applications of GSAT-6 were carried out.

Ground SW Quality Assurance

- Ground SW QA activities were carried out for 18 projects covering communication, navigation, and remote sensing payload data related ground applications including data products generation, data quality evaluation and data visualisation and analysis.
- More than 20 applications were covered in the process, including a few special purpose SW applications, named below: (i) RISAT-1 Data Products Generation SW for an International Ground Station; (ii) Procured E-Mail Solution for SAC; and (iii) Two web-applications for Centre users, developed by PPG.
- SW QA activities resulted in preventing SW bugs, early detection of bugs during development, and helped realising improved quality characteristics for the finished SW products, resulting in improved performance, better user interface, enriched scope of user-application features, to mention a few.

Project Portal Infrastructure

- A Project Portal Infrastructure (PPI) developed using an open-source content management system was operationalised to host project documents and facilitate collaboration among project team members, during mid-July.
- By year-end, about 10 projects have been hosted on PPI, serving about 100 users, catering to about 200 documents.
- Users have provided positive feedback on its utility.



Research & Development Activities

RESPOND

The Ongoing research projects of RESPOND are reviewed in Annual RESPOND Review at SAC and also six projects are reviewed in each meeting of RESPOND Review Committee. Most of RESPOND projects are of the duration of 2-3 years. There are 46 ongoing Research projects are reviewed as on March 31, 2015. In this year Annual Respond review was held in November 26-27, 2014. Apart from SAC Participants, there were 34 participants from various academic & other institutions. Thirty one Ongoing Projects were reviewed.

The Respond Directory - 2014 was published which contains the contact details of Key Persons of SAC, members of Respond Review Committee, Principal Investigators of ongoing respond projects and concerned SAC Focal Persons.

The annual report of Respond at SAC for the year 2013-14 and document on 'Research Areas of SAC' were released.

TDP & R&D Program

Document on "Evaluation of completed TDP/R&D projects" was prepared. This document contains evaluation of 22 TDP/R&D Activities, which covers Concept, Outcome, Evaluation of Completed TDP/R&D activities and financial support. The overall outcome from 22 completed TDP/R&D activities under various parameters is as follows.

- Papers Published : 12
- Methodology/ Techniques delivered: 11
- Algorithms/ Software/ Model developed : 15
- Hardware developed : 16



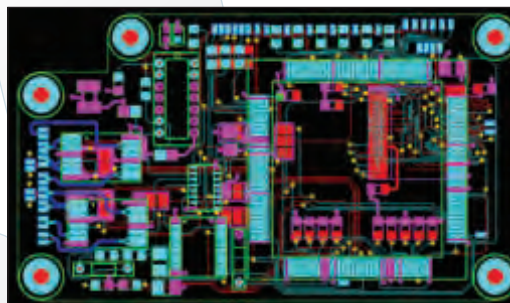
89±1.5 GHz Front-End Receiver with LO



Rapidly deployable Multi-band VSAT Terminal for Disaster Management



Resonant converter EPC - DVM



Transmit Receive Integrated Module Controller (TRiM-C)

Management Support Activities

Projects and Progress Monitoring

Progress monitoring of various ongoing projects in the Centre, independently and through various committees, assessing and coordinating the resource requirements, identifying critical areas and generating follow-up action items are crucial activities to keep the projects on track. In order to evolve an effective Project Monitoring mechanism in the centre, a compilation of the scheduled activities and sub-tasks of all the projects and TDP activities of the centre are carried out. Monthly progress & status of the Centre is generated every month from the inputs of the Divisions/Groups and Areas in the Centre and a highlight of the activities is sent to Head quarters. An Archival of the monthly progress reported by various division, groups and areas is being maintained.

In order to have comprehensive and independent project monitoring a Collaborative Intra centre Review Mechanism is implemented through committees as mentioned below;

1. Communication & Navigation Systems Monitoring and Review Committee (CNMRC)
2. Remote Sensing Sensors Monitoring & Review Committee (RMRC)
3. Applications Projects - Monitoring and Review Committee

These Committees are responsible for monitoring the status and progress of on-going activities/projects in the respective areas and helping the project functionaries. They enable inter-entity coordination and help to identify the critical areas of the project.

A detailed compilation of the centre's activities was carried out and the Annual Report of the Centre for the year 2013 - 2014 was generated. Periodical reviews of several ongoing projects by Director, SAC were arranged. Problem areas were highlighted during the review and action items generated were followed for timely resolutions.

Budget Planning & Monitoring

Overall budget of the centre is monitored through regular expenditure reviews with purchase, account and Budget Coordinator to realize the targeted spendability. Centre budget expenditure was depicting the smooth and well planned operation of the centre where spending of the total annual budget was 25.99% in first quarter, 27.95% in second quarter, 28.22% in third quarter and 27.45% in fourth quarter.

In addition to this, during the year Spendability analysis, Preparation of inputs for performance budget document, Re-conciliation of budget proposals with HQ guidelines, Re-conciliation of budget proposals vis-à-vis the approvals from ISRO council, Preparation of operation budget document through COWAA Finance Module were prepared.

Human resource development (HRD) activities

Human Resource Development Division is playing a major role in providing learning platforms for SAC/DECU employees through Training & Development activities.

HRDD carried out a Training Need Identification/Training Need Analysis (TNI/TNA) exercise for a period

of three years 2015-2018 to cope up with fast moving technology changes. This exercise resulted in bringing out a TNI/TNA: 2015-18 document. HRDD also published a document of Higher Study Profile 2001-2014. 10 in-house programmes were designed and organized during 2014-15 that accommodated about 350 participants. This includes a Structured Training Programme (STP) on Satellite Communication, a specialised Technical Programme on CMOS Analog Design in association with IIT-Kharagpur for ISRO level participants and one programme exclusively for administrative personnel in association with Institute of Secretariat Training and Management (ISTM), New Delhi. Besides, HRDD organized 5 other programmes including Seminars and IIST B.Tech Counselling.

A unique event-UMANG: IITPian Meet @ SAC was also organised on November 15, 2014 for all IITPians working at SAC & DECU. The meet is first of its kind in ISRO to bring all IITPians in a single platform. 269 IITPians attended the event. 57 papers received from different areas. UMANG website was also developed to manage the event almost paperless way. HRDD conducted online survey of IITPians for profiling the Big-five personality and organisational commitment (OC). Ms. Arunima Sinha, The First Female Amputee to Climb Mount Everest inspired all by narrating her life experiences in her keynote address.

HRDD organized 8 lectures under Knowledge Sharing Series and 16 lectures under SAC Lecture Series. 339 staff members deputed to various conferences/seminars/training courses/et al. HRDD facilitated to place 219 students of various universities to work with scientists/engineers for their internship under SAC Academic Associate Programme. 3 educational visits were arranged as part of image building acidity. HRDD has developed a web based system for processing nomination and collecting feedback online. Testing of s/w has been completed successfully.



'UMANG' celebration at SAC



KYA: 'MOM; challenges & outcomes'

Intellectual Property Rights & Technology Transfer

SAC has signed five Technology Transfer agreement in this year:

1. 15 W C-Band SSPA to M/s AMPL and M/s KAL on September 8, 2014
2. PRECISION TAPPING MECHANISM to M/s. Surelia Wire-cut Pvt Ltd & M/s. Technocom Dies & Precision Products
3. Photosynthesis Irradiance Incubator (PI Box) -Designed and developed for marine and fresh water applications for measuring the photosynthetic-rate parameters of Phytoplankton. M/s Tulsi Industries on Sept 2014

A MOU was signed with Chaitanya Bharathi Institute of Technology, School of Engineering & Technology, Jain University, L. J. Institute of Engineering & Technology, IIT Gandhinagar and SAC to have collaboration in IRNSS Navigation Receiver field Trial and Data collection.

The broad objectives of this MoU are:

- To install the SAC developed IRNSS receiver in the premises of the institutes.
- The institutes shall collect the data and send it to SAC.
- Both SAC and institutes shall carry out research on the subjects of mutual interest.

A consultancy agreement was signed for Providing Technical Consultancy On Development of Radar Level Transmitter with SAPCON Instruments Private Limited, Indore (M.P) on April, 2015

A Testing consultancy was signed with M/s SUMERU Microwave , Ahmedabad on antenna system from antenna test range facility.. Test Report on 3.5m Shaped Reflector Antenna for Cosc Square Pattern was characterized at CATF-SAC, Ahmedabad.

Testing facility utilization facilitated to Industries from April 2014 to March 2015 :

Sr. No.	Company	Name of test	Amount
1	M/s VCB Electronics Pvt. Ltd.	Use of laser welding facility	Not done
2	M/s BEL, Ghaziabad	EMI EMC Testing on MMIC C band receiver	43,024
3	M/s Syratron Technologies	Hogh Power test on WR-75 Ku band 250W load	Not done
4	M/s Sumeru Microwave Communications Pvt. Ltd.	3.5m X band Antenna Testing	2,00,000
5	M/s Centum Electronics Limited	EMI EMC testing on EPCs	1,43,400
6	M/s Centum Electronics Limited	Consultancy charges towards MIC facility audit and qualification/certification	1,53,172
	M/s Astra Microwave Products Limited	Micro-Section of Alumina Substrate	

Manpower & Information Systems

Manpower and Information systems is responsible for Design, Development, Implementation, Operation & Maintenance of various softwares and websites developed for administrative divisions of SAC.

During the year 'हिन्दी ज्ञान प्रबंधन अनुप्रयोग' software was developed and implemented. It has many features like Capture hindi name of employee, Capture hindi knowledge Information of Employee, Web Based User Friendly Interface, Automation of hind knowledge of employees for various MIS purposes, Generate various reports as per prescribed formats etc. CHSS card renewal software was also developed, which provide an integration of Hardware(Bar Code Readers, Camera, Card Printer, Computer System) & Software, will support the administration to renew the CHSS card.

Capacity Building

SAC is actively involved in conducting UN sponsored technical courses for students of different developing countries in the Asia Pacific region.



Participants of 3rd NAVSAT Course with dignitaries



Participants of SATCOM-9 Course with dignitaries

The 3rd international short training Course on Navigation and Satellite Positioning Systems of CSSTEAP started on June 16, 2014 and concluded on 11 July, 2014 at SAC Ahmedabad. Nineteen participants from eight countries of Asia Pacific region have attended this course. The Valedictory function was held on 11 July 2014 at Bopal Campus, SAC.

The Ninth Post Graduate Diploma Course in Satellite Communications (SATCOM-9) of CSSTEAP started on August 01, 2013 and concluded on 30 April, 2014 at SAC Ahmedabad. Sixteen participants from six countries of Asia Pacific region, namely Bangladesh, India, Mongolia, Nepal, Uzbekistan and Vietnam have attended this course.

Space Exhibition (VSSE)

On the occasion of National Remote Sensing Day, VSSE arranged a mobile exhibition at Medhasan village near Modasa (N G) on August 12, 2014. About 1000 students visited exhibition. During the year VSSE has organized various mobile exhibitions, in different part of Gujarat. About 32 thousand visitors are registered during the exhibitions.

World Space Week was celebrated on October 8-9, 2014 and an exhibition was arranged at Vikramnagar. More than 1600 people were visited the exhibition. Some other programmes like Quiz competition related to ISRO were also arranged on this occasion and token gift was given to winners. An educational visit for students from JECRC College of Engineering Jaipur was arranged on January, 17, 2015.

An exhibition showcasing SAC past & current activities & achievements in form working models, static models, posters from all areas with regular VSSE mobile exhibits was arranged in IIT-Gandhinagar on 11th & 12th October during their Tech festival Amlethea-14. About 70K thousand visitors from various engineering colleges & professionals visited our stall.

During Gujarat State level Municipal Schools Science fair at Surat city, VSSE has organized exhibition in December. About 1.2 lakh students & teachers visited the fair.



World Space day week celebrations at SAC



Eductional Visit for students from JECRC College of Engineering Jaipur

वर्ष 2014 -2015 के दौरान केंद्र में संपन्न हिंदी गतिविधियों की रिपोर्ट

25 जुलाई 2014 को “ भारतीय अंतरिक्ष कार्यक्रम - आत्मनिर्भरता एवं चुनौतियां ” विषय पर हिन्दी तकनीकी संगोष्ठी का आयोजन किया गया, इसके साथ ही “ हिंदी में वैज्ञानिक तकनीकी लेखन एवं राजभाषा का स्वरूप ” विषय पर राजभाषा सत्र भी शामिल किया गया। संगोष्ठी में अंतरिक्ष विभाग/ इसरो के विभिन्न केंद्र/ यूनिटों से पधारे वैज्ञानिक/ अभियंताओं और वरिष्ठ अधिकारियों ने सहभागिता की। संगोष्ठी के लेख-संग्रह का विमोचन किया, लेख संग्रह संगोष्ठी के लेखक प्रतिभागियों द्वारा प्रस्तुत लेखों का संकलन है। संगोष्ठी के लेख-संग्रह को सीडी के रूप में भी तैयार किया गया था। संगोष्ठी का आयोजन कुल चार सत्रों में किया गया, जिनमें से तीन सत्रों में तकनीकी लेख प्रस्तुत किए गए और अंतिम एक सत्र में राजभाषा हिंदी से संबंधित लेख प्रस्तुत किए गए। प्रत्येक सत्र की सर्वश्रेष्ठ प्रस्तुतियों तथा संगोष्ठी के अन्य प्रतिभागियों को प्रमाण-पत्र प्रदान किए।

सैक तथा डेकू में विगत कई वर्षों से हिन्दी माह का आयोजन किया जाता है जिसमें कार्यालय के कर्मचारी अत्यंत उत्साह से प्रतिभागिता देते हैं। वर्ष 2014 में भी सितंबर माह के दौरान हिंदी माह का आयोजन किया गया। हिन्दी माह के दौरान आयोजित विविध 12 प्रतियोगिताओं में से 2 प्रतियोगिताएं हिन्दी प्रश्नमंच एवं हिन्दी काव्यपाठ में स्टाफ सदस्य तथा दर्शक गण उल्लास के साथ भाग लेते हैं। हिन्दी प्रश्नमंच प्रतियोगिता दो भागों में पहले ऑनलाइन (स्टाफ सदस्य अपने डेस्कटॉप पीसी से भाग ले सकते हैं) तत्पश्चात् मौखिक रूप से आयोजित की जाती है, जिसमें प्रतिभागियों तथा स्टाफ सदस्य काफी उत्साह का प्रदर्शन करते हैं तथा प्रतिभागियों की संख्या दिन प्रतिदिन बढ़ते हुए गत वर्ष 1600 हो गई थी। हिन्दी माह के दौरान कर्मचारियों के बच्चों तथा विवाहितियों के लिए भी विविध प्रतियोगिताएं आयोजित की जाती हैं, जिसमें विवाहितियों के लिए आयोजित हिन्दी अंताक्षरी प्रतियोगिता काफी रोचक व लोकप्रिय हैं। हिंदी माह के दौरान 01 सितंबर से 30 सितंबर 2014 तक सैक पुस्तकालय में वर्ष के दौरान खरीदी गई हिंदी पुस्तकों की एक प्रदर्शनी भी आयोजित की गई।

अंतरिक्ष उपयोग केंद्र तथा डेकू द्वारा विगत कुछ वर्षों से गुजरात राज्य के ग्रामीण क्षेत्रों के विद्यार्थियों को अंतरिक्ष विज्ञान की प्रगति, समाज के उत्थान में इसकी भूमिका तथा अंतरिक्ष विज्ञान के प्रति रुचि जागृत करने के उद्देश्य से भारतीय अंतरिक्ष कार्यक्रम की झलकियां कार्यक्रम आयोजित किया जाता है। वर्ष 2014 में कार्यक्रम का आयोजन गुजरात के पाटण जिले के झिलिया गाँव में किया गया, जिसमें सैक एवं डेकू के वरिष्ठ वैज्ञानिकों ने भारत के प्रथम अंतरग्रहीय मिशन मंगलयान तथा इसरो के विविध कार्यक्रमों तथा उनके सामाजिक अनुप्रयोग के बारे में सरल हिन्दी तथा गुजराती भाषा में छात्रों को जानकारी प्रदान की। कार्यक्रम के दौरान छात्रों ने कई प्रश्न पूछकर अपनी जिज्ञासाओं का समाधान भी किया। इस दौरान छात्रों के लिए अंतरिक्ष प्रदर्शनी का भी आयोजन किया गया। इस कार्यक्रम से लगभग 4000 से भी अधिक छात्र लाभान्वित हुए।

निदेशक, सैक की अध्यक्षता में सैक की राजभाषा कार्यान्वयन समिति की 137वीं, 138वीं, 139वीं तथा 140 वीं बैठक का आयोजन किया गया। जिसमें संबंधित तिमाहियों के दौरान केंद्र में राजभाषा नीति के अनुपालन की समीक्षा की गई। राजभाषा कार्यान्वयन से संबंधित महत्वपूर्ण चर्चा की गई तथा केंद्र में प्रभावी राजभाषा कार्यान्वयन के लिए महत्वपूर्ण निर्णय लिए गए। समिति में चर्चा के उपरांत राजभाषा विभाग द्वारा जारी वार्षिक कार्यक्रम 2014-2015 की प्रति सभी संबंधितों को परिचालित की गई।

वर्ष के दौरान 04 राजभाषा कार्यशालाओं का आयोजन किया गया जिनमें 13/05/2014 को प्रशासन क्षेत्र के 33 अधिकारियों, 28/08/2014 को वैज्ञानिक/अभियंता एसई (प्रथम बैच) के अंतर्गत 88 अधिकारियों, 30/12/2014 को वैज्ञानिक/अभियंता एसई (द्वितीय बैच) के अंतर्गत 99 अधिकारियों और 24/02/2015 को वैज्ञानिक/अभियंता एसई (तृतीय बैच) के अंतर्गत 97 अधिकारियों को संघ की राजभाषा नीति, नियम तथा कंप्यूटर पर हिंदी में काम करने संबंधी प्रशिक्षण प्रदान किया गया।

अप्रैल 2014 के दौरान हिंदी गृह पत्रिका अभिव्यक्ति के 8वें अंक का विमोचन निदेशक, सैक द्वारा किया गया। पत्रिका अंतरिक्ष विभाग/ इसरो के विभिन्न केंद्र/यूनिटों को प्रेषित की गई।

इसरो में कम्प्यूटर कार्यप्रवाह प्रणाली (कोवा) के माध्यम से जारी किए जाने वाले विविध आदेशों को द्विभाषी में जारी किए जाने के लिए सैक द्वारा कोवा हिन्दी प्रणाली का विकास किया गया। इसरो के विविध केंद्रों/यूनिटों द्वारा इस प्रणाली का उपयोग द्विभाषी आदेश जारी किए जाने के लिए किया जा रहा है।

सैक के एमआईएसडी प्रभाग के सौजन्य से हिन्दी प्रशिक्षण रोस्टर प्रणाली तैयार कराई गई। इस प्रणाली के माध्यम से कोवा से इनपुट प्राप्त कर कर्मचारियों के हिन्दी ज्ञान तथा हिन्दी प्रशिक्षण का अद्यतन रोस्टर तैयार किया गया।

हिन्दी शिक्षण योजना के अंतर्गत सैक में नवनियुक्त 11 प्रशासनिक सहायकों के लिए अगस्त-जनवरी 2014 सत्र के लिए कम्प्यूटर पर हिन्दी टंकण प्रशिक्षण दिनांक 07.08.2014 से शुरू किया गया। जुलाई 2014 के तीसरे सप्ताह में हिन्दी शिक्षण योजना द्वारा आयोजित हिन्दी टंकण परीक्षा में इस केंद्र के 15 सहायकों ने हिन्दी टंकण की परीक्षा में भाग लिया। हिन्दी टंकण प्रशिक्षण हेतु शेष 08 कर्मचारियों को हिन्दी शिक्षण योजना के अंतर्गत जुलाई 2015 में आयोजित होने वाली परीक्षा के लिए प्रपत्र भरवाकर भेजे गए।

इसरो के विविध केंद्र/यूनिटों में सर्वप्रथम सैक द्वारा अपनी इंटरनेट वेबसाइट का हिन्दी में विकास किया गया। सैक की वर्तमान इंटरनेट साइट व्योम अंग्रेजी तथा हिन्दी में एक-साथ अद्यतित की जाती हैं। द्विभाषी में तैयार आंतरिक वेबसाइटों जैसे- पुस्तकालय, एमआईएसडी, एनएनआरएमएस तथा अक्षयपाल को द्विभाषी रूप में अद्यतित किया गया वर्ष 2014-15 के दौरान लोकार्पित 'अनुभव' वेबसाइट में भी हिन्दी में जानकारी प्रदान की गई है।

वर्ष के दौरान अधिकतर कार्यालयीन काम हिन्दी में करने हेतु लागू प्रोत्साहन योजना के अंतर्गत हिन्दीतर भाषा वर्ग एवं हिन्दी भाषा वर्ग के 14 स्टाफ सदस्यों को पुरस्कार प्रदान किया गया। इसके अलावा तकनीकी अनुभागों में हिन्दी कार्यान्वयन को बढ़ावा देने के उद्देश्य से वर्ष के दौरान प्रोत्साहन योजना लागू की गई तथा पुरस्कार प्राप्त करने वाले तकनीकी अनुभागों को गणतंत्र दिवस के अवसर पर निदेशक द्वारा शील्ड प्रदान की गई।

हिन्दी कार्यान्वयन समीक्षा समिति द्वारा सैक तथा डेकू के आंतरिक अनुभागों का निरीक्षण किया गया तथा अनुभागों में हिन्दी कार्यान्वयन को बढ़ाने के लिए समिति द्वारा एक रिपोर्ट निदेशक को प्रस्तुत की गई। निदेशक महोदय के आदेश से समिति की सिफारिशों के आधार पर संबंधित अनुभागों को हिन्दी कार्यान्वयन के अनुपालन के लिए निर्देश जारी किए गए।

अंतरिक्ष उपयोग केंद्र तथा विकास एवं शैक्षिक संचार यूनिट (डेकू), अहमदाबाद में जनवरी 2015 माह में विश्व हिन्दी दिवस मनाया गया। इस अवसर पर 09 जनवरी 2015 को सैक तथा डेकू के कर्मचारियों के लिए हिन्दी निबंध एवं हिन्दी अनुवाद प्रतियोगिता का आयोजन किया गया। प्रतियोगिताओं में कर्मचारियों ने उत्साहपूर्वक भाग लिया और उन्होंने कार्यालयीन एवं निजी जीवन में राजभाषा हिन्दी का अधिक से अधिक प्रयोग करने तथा अन्य लोगों को भी हिन्दी अपनाने के लिए प्रेरित करने का संकल्प दोहराया।

राजभाषा विभाग द्वारा जारी लक्ष्यों के अनुसार पुस्तकालय में हिन्दी पुस्तकों की खरीद की गई। जिसका विवरण निम्नानुसार है:

सामान्य पुस्तकों पर किया गया कुल खर्च	अंग्रेजी पुस्तकों पर किया गया कुल खर्च	हिन्दी पुस्तकों/पत्रिकाओं पर किया गया खर्च	हिन्दी पुस्तकों पर किये गए खर्च का प्रतिशत	कुल हिन्दी पुस्तकों की संख्या
₹.25599.00 (संदर्भ ग्रंथों को छोड़कर)	₹.4015.00 (सामान्य पुस्तकों पर, संदर्भ ग्रंथों को छोड़कर)	₹.60623.00 पुस्तक = ₹.21584/- पत्रिका/अखबार = ₹.39039/-	84.32%	95

निदेशक, सैक के निदेशानुसार प्रशासनिक क्षेत्र के सभी कर्मचारियों को उनके अनुभाग में जाकर हिन्दी अनुभाग के कार्मिकों द्वारा कम्प्यूटर पर हिन्दी में कार्य करने का प्रशिक्षण प्रदान किया गया।

अंतरिक्ष विभाग द्वारा जारी विक्रम साराभाई मौलिक हिन्दी पुस्तक लेखन योजना का सभी स्टाफ सदस्यों के बीच व्यापक परिचालन किया गया।

केंद्र के सेवानिवृत्त होने वाले कार्मिकों के लिए प्रत्येक माह आयोजित होने वाले विदाई समारोह संबंधी सभी कार्य हिंदी में किए गए।

केंद्र की मासिक प्रगति रिपोर्ट का हर माह नियमित रूप से हिंदी रूपांतरण तैयार कर विभाग को प्रेषित किया गया।

निदेशक, डेकू ने 26 जनवरी 2015 को अंतरिक्ष उपयोग केंद्र परिसर में गणतंत्र दिवस समारोह के दौरान सैक/ डेकू में हिंदी कार्यान्वयन से संबंधित विभिन्न गतिविधियों/ प्रोत्साहन योजनाओं के विजेता प्रतिभागियों/ अनुभागों को विविध श्रेणियों में उत्कृष्ट कार्यनिष्पादन के लिए पुरस्कृत किया।

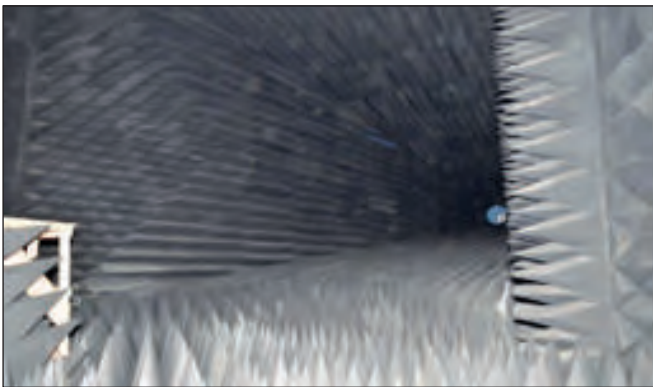
पुरस्कार

- अंतरिक्ष उपयोग केंद्र को वर्ष 2014-2015 के लिए नगर राजभाषा कार्यान्वयन समिति द्वारा राजभाषा नीति के सर्वश्रेष्ठ कार्यान्वयन के लिए द्वितीय पुरस्कार से सम्मानित किया गया।
- वर्ष 2014-15 में नगर राजभाषा कार्यान्वयन समिति द्वारा विकास एवं शैक्षिक संचार यूनिट (डेकू) को राजभाषा नीति के सर्वश्रेष्ठ निष्पादन के लिए प्रथम पुरस्कार से सम्मानित किया गया।
- 25 एवं 26 नवंबर 2014 को आईजेक द्वारा अंतर केंद्र तकनीकी हिंदी संगोष्ठी का आयोजन किया गया। अंतरिक्ष उपयोग केंद्र के (15) प्रतिभागियों ने प्रत्यक्ष एवं विडियो कॉन्फ्रेंसिंग के माध्यम से अपने लेख प्रस्तुत किए। इसमें से तीन लेखकों को उत्कृष्ट प्रस्तुतीकरण हेतु पुरस्कृत किया गया। अनुजा शर्मा, वैज्ञानिक अभियंता को एनआरएससी, हैदराबाद में 19 जनवरी 2015 को आयोजित तकनीकी हिंदी संगोष्ठी के अंतर्गत राजभाषा सत्र में सर्वश्रेष्ठ लेख के लिए प्रथम पुरस्कार प्रदान किया गया। एड्रिन, हैदराबाद में 20 जनवरी 2015 को आयोजित तकनीकी हिंदी संगोष्ठी के अंतर्गत राजभाषा सत्र में श्री राजेंद्र गायकवाड़, वैज्ञानिक/ अभियंता, सैक को सर्वश्रेष्ठ लेख के लिए प्रथम पुरस्कार प्रदान किया गया।

Major Civil Works

This year SAC has undertaken 12 Capital Civil works and 200 minor & maintenance works costing Rs.7500 lakhs. Few of the important works completed during the period are as under :

- Plane polar near field (PPNF) and tapered anechoic chamber --The building is first of its kind antenna measurement facility having tapered anechoic chamber built in RCC.
- Co-ordinate measuring machine (CMM) building: The building is having high bay area of 9.0 mtr. Height.
- Mechanical materials & fasteners stores (MMFS): The building is having high bay of height 7 m and central span of 15 m with mechanical EOT crane of 5 Ton.
- Extension, modification & renovation of SAC guest house
- Modification and renovation in room no. 5206 (clean room) in building no. 52 at sac campus: The existing Checkout Lab - 1 has been converted into class 10,000 Clean Room by providing 12 nos FFU (Fan Filter units) and ducting modification along with new Air Shower exclusively for the area with PVC false ceiling, wall paneling work.
- Annexe to IRS clean room in building no. 47 at SAC



Interior view of Tapered chamber



Clean room in building No: 5206



Interior view of high bay area of MMFS



Exterior view of guest house showing entrance

Some of the other completed works are as under:

- Feed integration lab & CAD lab.
- Extension of central stores.

Work in Progress

- Payload integration lab at new land bopal.
- Augmentation & extension of existing vikram sarabhai space exhibition building.
- Vertical extension of building no. 30-D at sac.
- Vertical extension of building no. 38 at sac.
- FM antenna container & fixture storage room near CATF building at sac.

Energy saving measures adopted at SAC

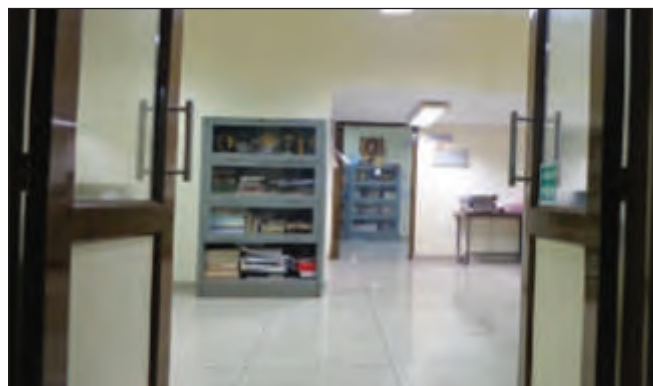
- Efficiency measures in power supply and distribution system: Based on comprehensive reviews and energy audit, power factor of SAC Campus has been improved to 0.99 by providing capacitor bank at load point. These has resulted in energy saving to the tune of Rs.13.0 lakhs (i.e.2.00 lakhs kwh) in a year.
- Replacement of existing very old ac plant with energy Efficient AC plant: Due to adoption of above stated energy conservation measures, SAC has saved energy charges to the tune of Rs. 40.90 lakhs in a year.

The Maintenance work had carried out 200 nos. of Minor & Maintenance works costing Rs. 2120 lakh (approx.) at SAC , Housing colonies , Bopal campuses , Delhi Earth Station . Some of completed works are shown below:

- Horizontal extension of building No.30 D
- Renovation of F.F & S.F of Library
- Renovation of C3 block at Vastrapur
- Renovation of Hindi Cell



Horizontal extension of building No.30



Renovation of Hindi Cell

Administrative and Auxiliary Activities

Finance & Accounts

Finance & Accounts Division at SAC is responsible for maintenance of sound accounting system as per departmentalization of Accounts and meeting expenditure & commitment over budget allocations with respect to centre & projects. During the F.Y. 2014-15 778.59 crores expenditure and 783.10 crores cash flow were recorded under PAO, SAC.

Number of claims handled under different categories. Detailed information is given in a tabular form:

Sr. No.	Nature of Claims	Numbers
1	CHSS	65,154
2	TA/LTC/FTA	10,125
3	Foreign Bills	6,589
4	Local & Miscellaneous, Contingency & Imprest	14,186
5	CMD Bills	2,715
6	PF, Loans, Advances	1,785
7	Pre-Audit	3233
8	Pension /Gratuity /Commutation /Family Pension /Revision of Pension	637

Weeding out of old records started in all sections & is still under progress. based on Record Retention Schedule. Accounts personnel /Officers have to participate in various committees like NAC-I & II, CFC-I & II, JPC, SPC, SOC, TWC-AMC, Negotiation, Survey & Condemnation, Tender Opening (Purchase/CMD), Transport, Uniform & Liveries, Recruitment & Review, CHSS, Canteen etc., which requires considerable amount of time and taken care of very efficiency and effectively.

Submission of consolidated Monthly Accounts & Supplementary Accounts, Consisting of "Receipts and Payment" to Chief Controller of Accounts w.r.t. Detailed Demand for Grant is one of the major work as per departmentalization of Accounts. Preparation of Budget Estimates & Revised Estimates is one of the tasks at section.

Purchase and Stores

Purchase and Stores played significant role for overall activities of the Centre. During this year, about 2450 indents worth approximately 590 Crores were received & processed and about 2400 orders worth approximately 340 Crores were released. About 1530 tenders were issued and approximately 554 Import consignments were cleared from Customs.

In Stores about 2214 consignments were handled during the year. Specialised transportation was arranged for 15 payloads to ISAC. In connection with MOU signing for IRNSS receivers, 14 numbers of IRNSS receivers were packed and dispatched to different centres and academic institutes. Regular meetings were conducted for Improved Work Culture (IWC) and inspection were completed at Bopal campus, KV-SAC & 14 buildings in SAC.



Events

- Fire Service Week celebrated by Fire Wing, CISF during April 14-20, 2014. During this, a large number of employees and support staff participated in Basic Fire Fighting Training.
- Blood Donation camp was organized at SAC on July 2, 2014. About 190 units of blood were collected.
- Indian Meteorological Society, Ahmedabad Chapter organized 9th Prof. Satish Dhawan Lecture on "Emerging Trends in Earth Observations from Space" by Shri A S Kiran Kumar, Director, SAC on July 11, 2014.
- Independence day was celebrated at SAC and Director, SAC unfurled the National flag. On this occasion Director, SAC has given "Administrative Excellence Award" to 8 employees of SAC. A felicitation function for a few employees who have completed 25 years of service in DOS/ISRO was also arranged.
- The first NISAR science workshop was organized at Space Applications Centre (ISRO), Ahmedabad during 17-18 November 2014 with the primary objectives of informing and involving Indian scientific community about NISAR mission; exploring new applications of dual-frequency SAR data; and searching for collaborative opportunities in SAR applications. The workshop was attended by over 380 participants from 83 different institutions including government organizations, academic institutions and private sectors, spreading across India. A delegation of scientists from NASA, JPL and other US universities participated in the workshop.
- An initiative of green transportation in SAC campus was implemented on January 1, 2015. Initially 50 bicycles are arranged for movement of employees within SAC premises.



Blood donation camp at SAC



NISAR Science Workshop

- Shri Alur Seelin Kiran Kumar, Distinguished Scientist & Director, SAC took charge as Secretary, Department of Space, Chairman, Space Commission and Chairman, Indian Space Research Organisation (ISRO) on January 14, 2015.
- 66th Republic Day was celebrated in SAC campus, Director, DECU unfurled the National Flag. The meritorious students of SAC & DECU community who had topped in X & XII Board exams were awarded by Director, DECU.
- Ms. Nandini Ray Chaudhury, Sci/Eng., SAC has received Rachapudi Kamakshi Memorial Gold Medal for Young Geospatial Scientist'-2014 Award on February 10, 2015.
- Dr. Charles Elachi, Director, JPL and NASA-JPL team visited SAC on February 13, 2015 to discuss the ISRO-JPL/NASA collaboration project 'NISAR'. On this occasion, Director-JPL delivered a talk on 'Robotic Space Exploration: Now and in the future'.
- Shri Tapan Misra, Outstanding Scientist, took over as Director, SAC on February 17, 2015.
- National Safety Week celebrated during March 04 to March 10, 2015. Activities like Essay Competition, Mock Fire Drill Competition, Painting Competition and slogan competition were conducted on this occasion.
- SAC celebrated International Women's day on March 26, 2015. The theme of the programme was 'Empowering women....Empowering Humanity'.



NASA-JPL visit at SAC



Republic day celebrations at SAC



Women's day celebration at SAC

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