FOURTEENTH POST GRADUATE COURSE IN

SATELLITE METEOROLOGY AND GLOBAL CLIMATE

[SATMET - 14]

August 01, 2025 to April 30, 2026

MEMOIRS

Organised By:

SPACE APPLICATIONS CENTRE
INDIAN SPACE RESEARCH ORGANISATION (ISRO)
AHMEDABAD, INDIA

CENTRE FOR SPACE SCIENCE AND
TECHNOLOGY EDUCATION IN ASIA AND THE PACIFIC (CSSTEAP)
(AFFILIATED TO THE UNITED NATIONS)

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FOURTEENTH POST GRADUATE COURSE IN

SATELLITE METEOROLOGY AND GLOBAL CLIMATE

[SATMET - 14]

AUGUST 01, 2025 TO APRIL 30, 2026

At

SPACE APPLICATIONS CENTRE AHMEDABAD

MEMOIRS

CENTRE FOR SPACE SCIENCE AND
TECHNOLOGY EDUCATION IN ASIA AND THE PACIFIC (CSSTEAP)
(AFFILIATED TO THE UNITED NATIONS)

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डॉ. व. नारायणन

Dr. V. Narayanan

सत्यमेव जयते
भारत सरकार
GOVERNMENT OF INDIA

अध्यक्ष, अंतरिक्ष आयोग
व
सचिव, अंतरिक्ष विभाग
Chairman, Space Commission
&
Secretary, Department of Space

Message

It gives me immense pleasure to note that the 14th Post-Graduate Diploma Course on 'Satellite Meteorology and Global Climate' of Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP) conducted by Space Applications Centre (SAC), Ahmedabad is successfully concluding on April 27, 2026. The course has benefited Ten participants from Six countries of the Asia-Pacific region.

The course has covered applications of satellite-based observations in the study of atmosphere & weather systems, numerical weather prediction models, weather monitoring, nowcasting, cyclone monitoring, disaster management etc. In addition, the use of Indian satellite missions such as INSAT-3D Series, Megha-Tropiques, SCATSAT, SARAL in weather monitoring and forecasting has also been addressed.

I am sure that the participants have benefited from the course with the knowledge of the use of space-based meteorological data products and services. I hope that it would enable them to develop similar applications to meet the requirements in their countries.

I congratulate the participants for successfully completing the course and I encourage them to make full use of the knowledge and experience gained from this course in their home countries. I also compliment the faculty and staff of CSSTEAP and SAC for their efforts for successful conduct of the course. I extend my best wishes to the participants for a bright future.

(व. नारायणन/ V. Narayanan)

Dated: April 21, 2026

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CENTRE FOR SPACE SCIENCE AND
TECHNOLOGY EDUCATION IN ASIA AND THE PACIFIC (CSSTEAP)
(AFFILIATED TO THE UNITED NATIONS)

Dr. Raghavendra Pratap Singh
Director, CSSTEAP

MESSAGE

It gives me immense pleasure to note that the 14th Post Graduate Course in Satellite Meteorology and Global Climate (SATMET) organized by the Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP) is concluding successfully on April 27, 2026. I am also happy to note that ten participants from six countries of the Asia Pacific region will be receiving their diploma certificates.

I am glad to know that SATMET course is well designed and was conducted efficiently by the faculty of Space Applications Centre, Ahmedabad. I am sure the participants have immensely benefitted from the programme in updating their skills in advanced techniques of Satellite Meteorology and Global Climate. The knowledge acquired would surely help them and their country to take full advantage of the technology.

I congratulate all the participants for successfully completing the courses and wish them very best in their future endeavors.

राघवेन्द्र सिंह

(R.P. Singh)

सौम्य एस सरकार/ Somya S Sarkar
विशिष्ट वैज्ञानिक/ Distinguished Scientist
निदेशक / Director

सत्यमेव जयते

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Message

I am pleased to mention that the ***14th Post-Graduate Course on Satellite Meteorology and Global Climate (SATMET-14) of CSSTEAP, conducted at the Space Applications Centre (SAC),*** Ahmedabad, since August 1, 2025, is being successfully concluded on April 27, 2026.

10 participants from six different Asia-Pacific countries have successfully completed the SATMET-14 Course.

Global climate change predictions are the need of the hour today. Satellites play a vital role in meteorology and climate monitoring globally. Satellite data are being extensively used for meteorological applications and studies on global climate change. Advanced concepts of retrieval techniques are being used to study and understand different meteorological parameters like rain, cloud patterns, fog, snow, glaciers, ocean currents, etc.

Space Applications Centre, being one of the most important Centres of ISRO, has always been at the forefront in the development of satellite payloads and ground terminals and receivers as well as varieties of applications related to SATMET and conducting the associated research activities. The extensive participation of the distinguished SAC experts not only transformed this Course into a beacon of knowledge but also highlighted the Centre's ability to provide extensive capacity building of international standards.

I am sure that the knowledge imparted to the participants will result in substantial learning outcomes, equipping them with the ability to address various technological challenges. I firmly believe that all participants will significantly contribute to national development efforts of their respective countries by effectively applying the gained knowledge and experiences.

While extending my heartiest compliments to the Course participants, I take this opportunity to congratulate the organizers, faculty members, and focal points for their dedication and hard work in making it a resounding success.

सौम्य सरकार SSarkar

Place: Ahmedabad

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&
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And
CSSTEAP Governing Board Member
E-24, Agargaon, Dhaka-1207, Bangladesh

Message

I am delighted knowing that the participants of different countries from Asia and Africa have successfully completed the 14th SATMET PG Diploma Course at CSSTEAP. As a member of CSSTEAP Governing Board on behalf of BMD, I would like to extend my sincere congratulations to all participants for their innovation, dedication and hard work throughout this intensive program to be skilled meteorological professional.

SATMET plays a transformative role in meteorology, climate services, disaster risk reduction, and sustainable development. The knowledge and skills gained through this course will significantly strengthen their professional contributions to the national and regional development.

I also express my heartiest appreciation to the faculty members and organizers whose commitment and expertise have made this program successfully. Your cordial guidance continues to build the next generation of skilled professionals in satellite meteorological applications.

I wish all graduates continued success in their future endeavors.

30.03.26
(Md. Momenul Islam)
Director

MONGOLIAN ACADEMY OF SCIENCES

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Date 13 March 2026
Ref. 2/103

TO: Center for Space Science and Technology Education in Asia and the Pacific (CSSTEAP)

Letter of appreciation

Dear Colleagues at CSSTEAP

Congratulations to all the graduates who have successfully completed the 14th SATMET Course On Satellite Meteorology and Global Climate with a total of 10 participants from 6 countries.

This achievement is a testament to your hard work, dedication, and commitment to advancing your knowledge and skills in these specialized fields. Your contributions will undoubtedly have a positive impact on research, innovation, and problem-solving in the areas of Satellite Meteorology, Global Climate, Remote Sensing, Space, and Atmospheric Sciences.

Since its foundation in 1995, the Center for Space Science and Technology Education in Asia and the Pacific (CSSTEAP) has been provided the best contribution to build human capacity in the space science related GIS/ Remote Sensing, Satellite Meteorology, Global Climate, GNSS, Communication satellite and Its technology development within their associated countries.

I hope that this post-graduate courses have provided the necessary knowledge and skills for the graduates and helped them to achieve their future careers and goals.

I would like to send my regards to the graduates that programs encouraged their research capability to utilize the experiences and knowledge's in developing their networks and contributes to the sustainable development efforts of their countries and wishing all success.

I extend my sincere gratitude to the Director of CSSTEAP to successfully organized those courses and training programs.

Sincerely yours,

VICE PRESIDENT BUDEEBAZAR AVID

2325000805

AMBASSADOR

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Barakhamba Road, New Delhi-110001
Tel. : 23327361/23329218 Fax : 23326857

Message

It gives me immense pleasure to extend my heartiest congratulations to the participants of the 14th Post Graduate Diploma Course in Satellite Meteorology and Global Climate (SATMET) and the 14th Post Graduate Diploma Course in Space and Atmospheric Science (SAS) at the Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP), as they approach to the successful completion of their course.

As a Member of the Governing Board of CSSTEAP, I would like to express my appreciation to the Centre for its important role in advancing education, training, and regional cooperation in space science and technology. Through its academic programmes and professional training, CSSTEAP has made a significant contribution to strengthening institutional and human resource capacity across the Asia-Pacific region.

The partnership between Nepal and CSSTEAP has been exceptionally fruitful. Over the years, numerous Nepali students and professionals have benefited from the world-class faculty and cutting-edge research facilities provided by the Centre. These opportunities have helped develop skilled human resources in areas of growing importance such as earth observation, satellite-based communication, weather and climate applications, geospatial technologies, natural resource management, and disaster preparedness. For Nepal, such capacity-building remains highly relevant in supporting national development priorities and evidence-based planning.

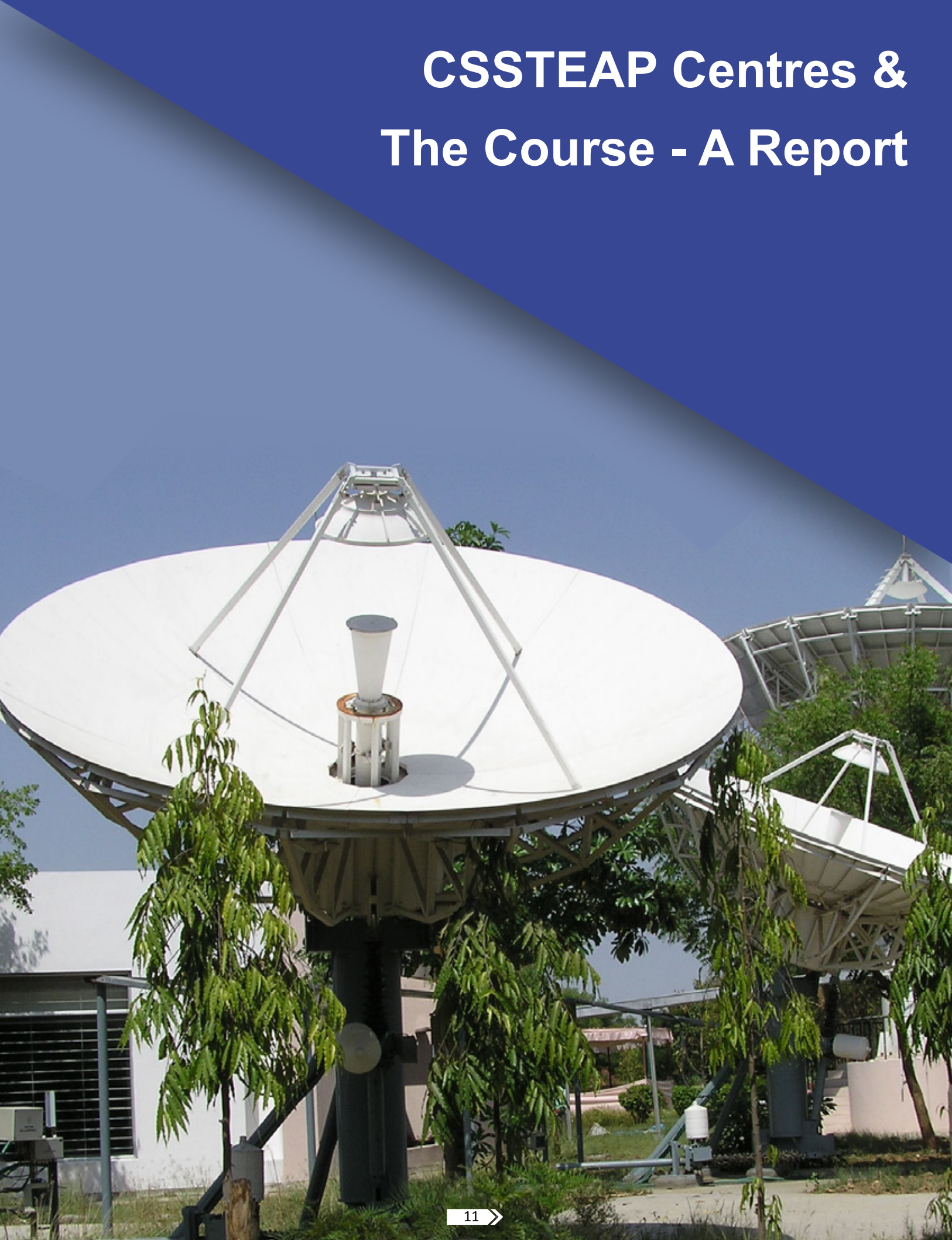
I wish all graduating participants continued success in their future endeavours and hope that CSSTEAP will continue to remain a centre of excellence for learning, innovation, and cooperation in the region.

I commend the faculty and staff of CSSTEAP for their tireless efforts in shaping the next generation of space scientists. May the Centre continue to reach new heights in its mission of capacity building and regional cooperation.

I wish the 14th SATMET and 14th SAS batches every success in their future endeavours.

Dr. Shankar P. Sharma
Member, Governing Board, CSSTEAP
New Delhi
March 30, 2026

CSSTEAP Centres & The Course - A Report



Centre for Space Science and Technology Education in Asia and the Pacific

Dr. Raghavendra Pratap Singh
Director, CSSTEAP

Introduction

In the modern era, the ability to monitor our planet's atmosphere in real-time has evolved from a scientific ambition into a global necessity. As we navigate the escalating challenges of climate change, global warming and sea-level rise, the precision of meteorological data serves as our primary defense against an increasingly volatile environment. This need for accuracy is nowhere more urgent than in the Asia-Pacific region.

Home to a complex array of weather systems—from the rhythmic pulse of the summer and winter monsoons to the formidable power of tropical cyclones—our region relies on the timely delivery of data to safeguard lives and manage vital resources. Historically, our scientific efforts have centered on mastering the quantitative prediction of the monsoon; today, we recognize that such foresight is only achievable through the synoptic vantage point of Satellite Meteorology. The Satellite Meteorology course stands at the crux of that mission, transforming orbital observations into the actionable intelligence required to navigate our shared future.

Focusing attention on Asia and the Pacific (AP) region of the globe, this region has become a hub of innovation, which is transforming the way in which people live, work, and relate to one another. Recent advancement in digital innovation such as artificial intelligence, big data analytics, the internet of things and cloud computing show promise to bring new and innovative solutions to pressing regional problems. Faster and more versatile digital connectivity, satellite-derived data, geographic information systems and spatial analysis have become increasingly accessible and available, generating more evidence-based data to support real-time decision-making. Geospatial information has also increasingly been incorporated in development planning, which has led to more accurate monitoring and evaluation of development interventions. As a result, geospatial information applications have come to play a more prominent role in the implementation and realization of the 2030 Sustainable Development Agenda (SDGs).

Despite advances in the availability and quality of space-derived information, several gaps and challenges remain for their effective use at the AP regional and national level. A lack of capacity and resources in terms of finance, space-derived data, knowledge and expertise, specific tools and well-trained human resources is a common problem. Many developing countries in the AP region still do not have the capacity to utilize, analyze and interpret space-derived data. Other challenges include issues related to policies, procedures, guidelines and standards for acquiring, sharing and utilizing space-derived products and services, and the lack of procedural harmony between agencies and countries.

Considering the importance and use of space science, technology and applications in promoting social and economic development, the United Nations, through its Office for Outer Space Affairs (UN-OOSA), facilitated the establishment and operation of the Regional Centres for Space Science and Technology Education. In its resolution 45/72 of 11 December 1990, the United Nations General Assembly (UN-GA) endorsed the recommendation of the Committee on the Peaceful Uses of Outer Space (COPUOS) to establish Regional Centres for Space Science and Technology in developing countries. Under the auspices of the United Nations, through its Office for Outer Space Affairs (UN-OOSA), six Regional Centres for Space Science and Technology Education have been established in the regions that correspond to the United Nations Economic Commissions for Asia and the Pacific (India and China), Africa (Morocco, Nigeria) and Latin America and the Caribbean (with offices in Brazil and Mexico) and Jordan for the West Asia region. The Centres are affiliated to the United Nations through UN-OOSA. Centre for Space Science & Technology Education in Asia and the Pacific (CSSTEAP) is the first Centre and was established on November 1, 1995 in India and has been Centre for Space Science and Technology Education in Asia and the Pacific imparting education/training in the areas of RS & GIS, Satellite Communications, Global Navigation Satellite Systems, Satellite Meteorology and Global Climate, Space and Atmospheric Science and Small Satellite Missions using modern infrastructure, technology and training tools and practices.

The Centre's headquarter is located in Dehradun, India, and its programs are executed by faculty of the Department of Space (DOS) at campuses in Dehradun, Ahmedabad, Hyderabad and Bengaluru. The Centre has arrangements with Indian Institute of Remote Sensing (IIRS), Dehradun for RS & GIS course; with Space Applications Centre (SAC), Ahmedabad for Satellite Communication (SATCOM), Satellite Meteorology and Global Climate (SATMET) and Global Navigation Satellite System (GNSS) and Navigation and Satellite Positioning Systems (NAVSAT) short courses; with Physical Research Laboratory (PRL), Ahmedabad for Space & Atmospheric Science course and UR Rao Satellite Centre (URSC), Bengaluru for short course on Small Satellite Missions and National Remote Sensing Centre (NRSC), Hyderabad for short course on Data Processing and Data Acquistion. The Centre also has agreement with the Government of India by which it has been accorded specific privileges and international status to the Centre, similar to the privileges enjoyed by UN specialized agencies. Under the agreement the Centre also has access to facilities, infrastructure and expertise of DOS/ISRO institutions, including IIRS, SAC, PRL, URSC and NRSC. The Centre has a Governing Board consisting of signatories from 18 countries from Asia-Pacific region and two observers, (UN-OOSA & ITC, The Netherlands). The Centre has formal UN affiliation with UN-OOSA for developing the CSSTEAP model and extending support in terms of expert advice, technical assistance, relevant documentation and future directions. The countries have agreed to the goals and objectives of the Centre by endorsing a cooperation agreement through which the Centre was established. The technical activities of the Centre are guided by an International Advisory Committee (AC) consisting of subject experts that critically reviews the curricula, technical facilities, expertise in terms of faculty, etc.

The course curricula developed by the Centre and endorsed by the United Nations are adapted for the educational programs. The educational programs of the Centre are oriented towards the dissemination of knowledge in relevant aspects of space science and technology. The Centre offers Post Graduate level courses in these five areas. The model of the PG courses is designed as to emphasize university educators, researchers and application scientists on the development and enhancement of knowledge and skills coupled with an application project with a small component (3 months) in India and major one (one year) in their home country with a view to transfer the technology

in their home organization. This gives an opportunity to the scholar to apply their knowledge and training received to deal with a 'real life' problem, where inputs from space technology can be used. Besides the Post Graduate level courses, the Centre also conducts short courses, workshops, awareness programs on specific themes in the four areas, highlighting how space-based information can be used for national development. These educational programs have benefited many scientists/engineers who will be the future policy & decision makers in several countries.

CSSTEAP conducts all of its educational programs in close collaboration with one of the DOS institutions and thus has direct access to their physical facilities and intellectual capabilities. In addition to providing facilities, infrastructure and skilled manpower, the Government of India, through the Department of Space provides most of the funding. Funding grants for international travel of participants, subject experts, tuition fees and scholarships of participants and the management of the Centre are mainly provided by Department of Space on behalf of Host country. UN-OOSA and UNESCAP in Bangkok also provides funding for travel of a few selected participants.

Educational Programs

The Centre offers post-graduate (PG) level training in five areas of specialization namely:

a) Remote Sensing and Geographic Information Systems (RS & GIS),
b) Satellite Communication (SATCOM),
c) Satellite Meteorology and Global Climate (SATMET)
d) Space and Atmospheric Science (SAS), and
e) Global Navigation Satellite Systems (GNSS).

Apart from these, Centre conducts short courses on different themes of Remote Sensing and GIS, Small Satellite Missions and Navigation and Satellite Positioning system, weather and climate on regular basis. The structure of PG Diploma and the short term programs is given in (Fig. 1 & 2). The Centre also organizes workshops & awareness programs from time to time.

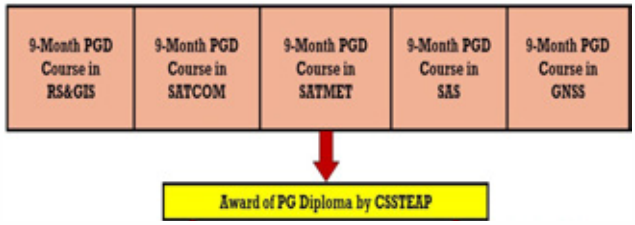


Fig. 1: Structure of PG Diploma Educational Programs at CSSTEAP

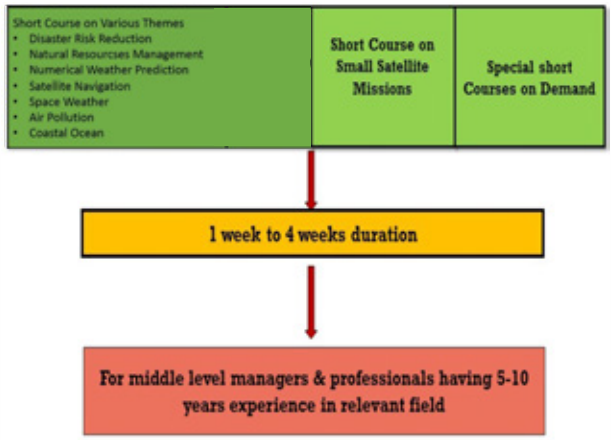


Fig. 2 Short term training programs at CSSTEAP

The educational programs are conducted in English and for participants who need help to improve their English language skills, facilities are made available upon their arrival in campus. The courses are taught in smart classroom environments with the use of modern teaching methods and tools, and also include multimedia tutorials for self-study. Practical are given in the laboratories and skill development environments of the DOS institutions. In each of the host institutions, most of the faculty are drawn from the host institutions (about 80% of the teaching time). Whenever desirable or needed, faculty is drawn from other DOS/ISRO institutions, or professional, scientific or academic institutions in India (~10%) or from institutions or organizations outside India, from the Asia-Pacific Region as well as globally (~ 5%). In order to provide wider exposure to the participants in their respective fields, the Centre provides opportunities for technical visits to scientific institutions, laboratories and national symposia in India. The successful completion of the 9-month PG-Phase of the programme leads to the award of a Post Graduate diploma by the Centre.

Till date 220 participants from 18 countries have been awarded M. Tech. Degree in the 5 disciplines (95 participants in RS & GIS; 60 in SATCOM; 24 in SATMET; 33 participants in SAS and 08 in GNSS). (Fig. 3)

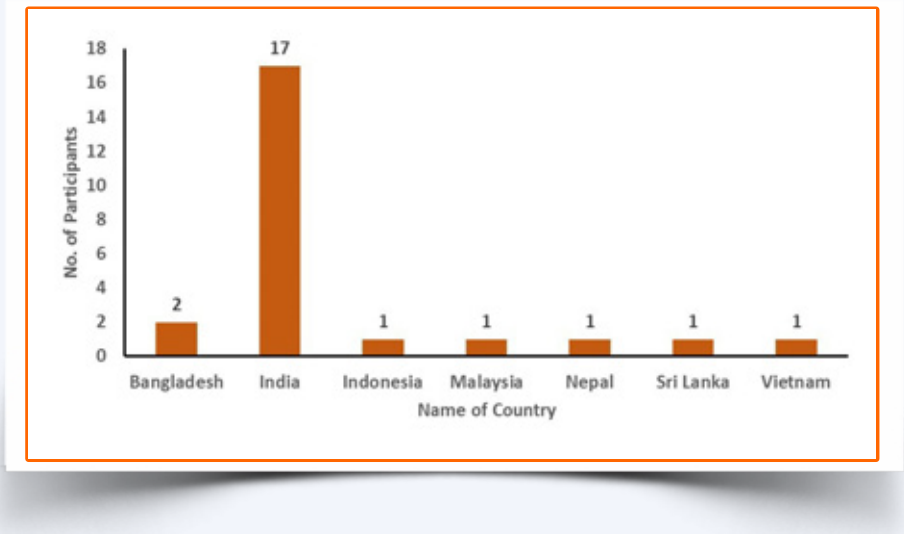


Fig. 3: Status of MTech degree awarded

Satellite Meteorology course

Anthropogenic intervention has led to large scale changes in our planet. With ever-growing population, compounded with increased industrialization, deforestation and pollution, the climate change impact is increasingly evident in our present day's world. The world encounters a severe shortage of essential resources (such as water, food, energy). In addition, the climate change and deforestation led to increased incidents of human-animal conflicts. It is inevitable to accept that the present human impacted world has brought in considerable stress on life on earth, life above the earth surface and life below in deep oceans.

Meteorological information is very crucial in sustainability of essential resources and disasters resilience. Meteorological information and their timely and real-time distribution, are of utmost concern to the region of Asia Pacific in particular. This region covers countries many of which

experience the typical tropical weather systems-especially Tropical cyclones and monsoons (both summer and winter) – and a few other the mid-latitude weather phenomenon. Global environment is also of great relevance for many countries of this region, particularly issues related to climate change, global warming, sea level rise, ozone depletion, etc. The understanding of meteorological information has been historically connected to our aspiration and ability to predict the quantitative aspects of the weather, so that it is possible for us to judiciously plan and manage resources. At present we realize better than ever that such an ability is obtainable only with the use of synoptic and real-time information, which is crux of satellite meteorology.

CSSTEAP conducts a comprehensive post graduate training programme of nine months duration on the subject with a complete treatment of principles, applications and prospects of using the technology to solve grass-root problems of nature concerning state, dynamics of atmospheric processes in the region and develop & manage of satellite meteorology and its applications in the countries of Asia-Pacific region. The PG course of 9 months is divided into two semesters including the pilot project in the second semester. The first semester covers basics in meteorology/ climatology, remote sensing, numerical techniques, satellite orbits, instrumentation, etc. In the second semester topics related to advanced concepts in satellite meteorology, geophysical parameter retrieval and applications, dynamical weather and climate models, assimilation techniques, climate issues, etc., are covered. This is followed by a pilot project. The topics of pilot project are decided based on the relevance to the participant's region.

The operational meteorological satellite data available in the AP region namely, INSAT, METEOSAT, GMS & NOAA are used extensively during the training course. The recent advances in non-optical remote sensing for meteorology is emphasized by using the data from Oceansat-1, ERS, DMSP, SSM/I, SCATSAT-1, SARAL-Altika etc. The computing facility is extensively updated and is being used for weather and climate model simulation. Facilities also include state of art GCM, mesoscale models (MM5, WRF), ocean circulation model, ocean wave model and image processing, graphic and visualization software, 4-D GIS etc. The course is conducted at Space Applications Centre (SAC) which is a nodal ISRO Centre for development of state-of-art meteorological space-borne sensors and also in numerical weather modelling. SAC is well equipped with the earth station to receive the satellite data (INSAT, NOAA) besides a strong laboratory support for experimental studies. An operational meteorological satellite data archival Centre exists at SAC. Support from India Meteorological Department and many other meteorological institutions spread over the country with their modern facilities, as well as the overseas experts are also available.

Achievements

Till date the Centre has conducted 73 PG Courses: 28 in RS&GIS, 14 in SATCOM, 13 each SATMET and SAS and 05 in Global Navigation Satellite System. In addition, the Centre has conducted 116 short courses including webinar and workshops in the past 30 years. These programmes have benefited more than 4380 participants from a total of 38 countries in the Asia-Pacific region. Moreover, 102 participants from 28 countries outside Asia Pacific region have also benefited from these educational programmes.

CSSTEAP has collaborated with GISTDA to organize an off campus course on “Crop Classification and Inventory” at GISTDA, Bangkok, Thailand where the expert from ISRO / CSSTEAP has trained around 89 participants. CSSTEAP has also planned an off campus course at Jakarta, Indonesia with BRIN to provide capacity building for participants from Indonesia and neighboring countries.

Space Applications Centre (SAC)

Harnessing Space Technology for Societal benefits

Shri Somya S Sarkar
Director, SAC

Space Applications Centre (SAC) is a major research and development centre of the Indian Space Research Organisation (ISRO), having multi-disciplinary activities. SAC has expertise in the design of space-borne and air-borne instruments for various ISRO missions, besides development & operationalisation of applications of space technologies ranging from communication, navigation, disaster monitoring, meteorology, oceanography, environment monitoring to natural resources management. SAC is spread across three campuses at Ahmedabad and one campus at New Delhi, Delhi Earth Station (DES).

The genesis of the centre dates back to 1966 with establishment of the Experimental Satellite Communication Earth Station (ESCES) by late Dr Vikram A Sarabhai in Ahmedabad. In 1972, the different units of ISRO in Ahmedabad pursuing research in applications of space technology, were merged to form the Space Applications Centre (SAC).

The major responsibilities of & activities carried out by SAC include:

- Design & development of payloads for ISRO Communication and Navigation missions
- Design & development of payloads and data products for ISRO Earth Observation missions, Space science & Interplanetary missions
- Development of space-based applications in the areas of Communication, Navigation and Earth Observation
- Design & development of systems for Gaganyaan
- Establishment and operationalisation of ground transmit/receive systems (Earth stations/ground terminals)
- Capacity Building & Public Outreach

In order to carry out these responsibilities, SAC has state-of-the-art electronic and mechanical fabrication facilities, highly sophisticated payload integration, climatic and environmental test facilities, systems reliability area, image processing and analysis facilities and project management support group. SAC collaborates with industry for sourcing, indigenisation & technology transfers, engages Indian universities with collaborative research programs, and propagates space technology and applications amongst students and public through in-house and mobile exhibitions. The Centre also conducts various short and long-term courses on SATCOM, SATMET and GNSS for students from the Asia Pacific region under the aegis of Centre for Space Science and Technology Education in Asia and Pacific (CSSTEAP) affiliated to United Nations. Vikram Sarabhai Space Exhibition (VSSE) at SAC is responsible for promoting and creating awareness in public at large about space activities through Mobile exhibitions and organizing various competitions & events.

The Organisation Structure of SAC

SAC has organized into the following major Areas or Groups:

- SATCOM & Navigation Payload Area (SNPA)
- SATCOM & SATNAV Applications Area (SSAA)
- Sensors Development Area (SEDA)
- Microwave Remote Sensors Area (MRSA)
- Earth, Ocean, Atmosphere, Planetary Sciences & Applications Area (EPSA)
- Electronic Support Services Area (ESSA)
- Mechanical Engineering Systems Area (MESA)
- Systems Reliability Area (SRA)
- Signal & Image Processing Area (SIPA)
- Antenna Systems Area (ASA)
- Human Spaceflight & Advanced Technology Area (HSTA)
- Management & Information Systems Area (MISA)
- Cyber services & Information Technology Area (CITA)
- Administration (ADMIN)

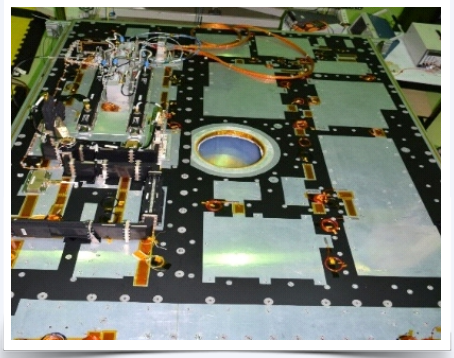
A profile of SAC Activities

Payload development Activities at SAC

SAC designs and develops payloads for Communication, Navigation & Remote sensing satellites. SAC delivered large variety of communication payloads operating from UHF to Ka, Q/V band & optical band to high through put satellites. SAC also developing earth observation instruments operating in optical as well as microwave wavelengths providing capability of high-resolution imaging. Below are several key milestones recently achieved by the Centre.

NISAR is the first mission to systematically and globally study the solid Earth, the ice masses, and ecosystems at a relatively high temporal sampling. The payloads of NISAR (S-band SAR from SAC/ISRO and the L-band SAR from JPL/NASA) was jointly developed by ISRO and NASA, and it as was launched on board GSLV-F16 on June 30, 2025. NISAR S-SAR data, downlinked majorly over Indian ground stations at NRSC, Hyderabad and Antarctica, is processed using NISAR Data Product

Generation Software (DPGS) to generate operational data products. NISAR data products, generated in Hierarchal Data Format (HDF-5), are freely available to the users which can be accessed through ISRO's Earth Observation data hub Bhoonidhi. (https://bhoonidhi.nrsc.gov.in). CMS-03, communication satellite for Indian Navy, is the heaviest communication satellite launched from Indian soil. India's LVM3 launch vehicle has successfully launched the CMS-03 communication satellite in its 5th operational flight (LVM3-M5) on November 02, 2025. In Orbit testing is under progress.

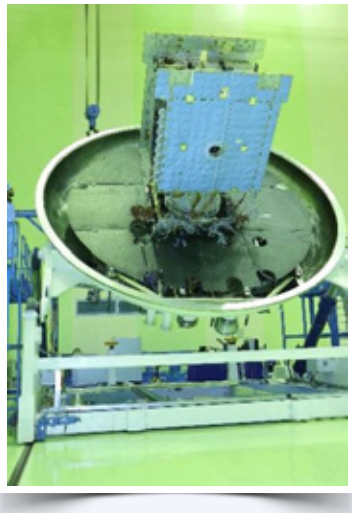


NVS-03 South Panel

Payloads of Indian Navigation satellite NVS-03 was realized in a very short time frame and is under spacecraft integration at URSC. It equipped with navigation payloads in L1, L2 & S-band, as well as ranging payload in C-band. Technology Demonstration Spacecraft (TDS-01) is being configured to demonstrate and validate in-orbit performance of new technologies before implementation on the operational spacecraft. Quantum TDS, SSV-GNSS, Ku Flexible and Q Beacon payloads delivered for spacecraft integration. Payload system of IDRSS-01 which will support low bit rate communication in S-band for Telemetry and Tele-command application for Gaganyaan as well as LEO missions is under spacecraft integration. A medium resolution wide swath multi-spectral imaging camera is envisaged for Indian Mauritius Joint Satellite (INS bus) for resource monitoring applications of Mauritian region and it is under final stage of integration.

SAC has been working on payload development for ISRO's planned Venus Mission, Chandrayaan-4 & LuPEX Mission. LuPEX is a collaborative mission with JAXA which is intended for Lunar Exploration.

Apart from this, payload activities for IDRSS-02, TRISHNA, G-20, NVS-04, RESOURCESAT-series, HRSAT series, SAQTI, GSAT-7B etc. are progressing well. SAC is also working on payloads of Space based Surveillance (SBS) mission, which is a series of programme undertaken by Government of India to deploy advanced surveillance satellites for enhanced land & maritime surveillance.



GSAT-7R integrated payload

Human Spaceflight Programme (Gaganyaan)

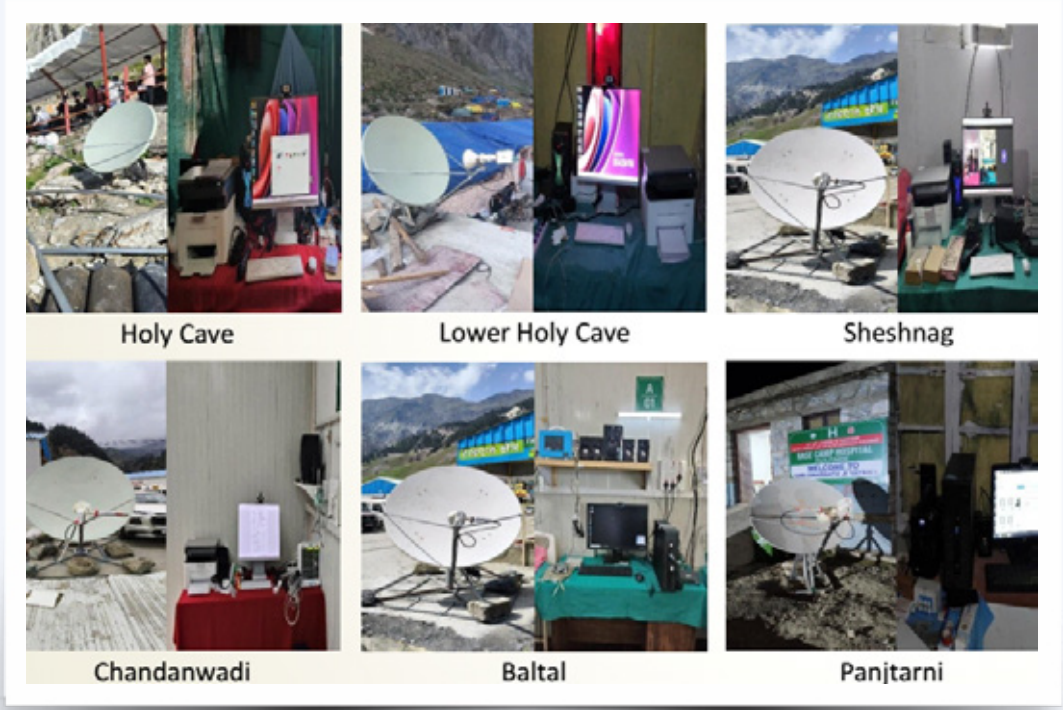
Human Space Programme (HSP) has been envisioned with the current and extended scope of the long-term human activities in space, which span from successfully sending humans into space to establishing a full scale Bhartiya Antariksh Station (BAS) and having further human Lunar Missions. SAC has been entrusted with the design and development of several critical system such as human centric Cabin and Communication Systems in order the meet the requirements of various missions of HSP.

All SAC deliverables for G1 & TV-D2 mission is completed. It includes Cabin Lighting, Location Transmitter, S-band Transceiver, Audio video processing, Crew Console, visible camera, Environment Monitoring (EMS), Handheld Environment Monitoring (HEM) systems & X-band Altimeter.

Systems for Gaganyaan-G2, Bharatiya Antariksh Station (BAS-1) are under design phase. SAC team participated in the Axiom-4 mission campaign and gained experience or development of subsystems for future Gaganyaan and BAS missions.

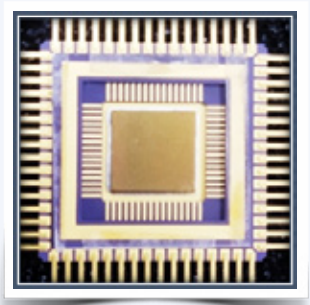
SATCOM & SATNAV Technology and Applications

SAC continues its contribution towards SATCOM, SATNAV & Navigation applications namely Vessel Communication and Support System for Monitoring, Control and Surveillance (VCS-MCS), DRT SATCOM Applications (DAT-SG), Real-time Train Information System (RTIS) etc. Recently 6 tele-medicine nodes was established along the route to Holy Cave Shri AmarnathJi to provide Tele-medicine facilities to pilgrims. SAC developed Chennai-SDMA Flood forecasting system and implementation to be undertaken by NSIL. Earth Receiving Station (ERS) of Bhakra Beas Management Board (BBMB) at Chandigarh was successfully operationalized by SAC DES team. This will support river water inflow forecasting and water distribution to Punjab, Haryana & Rajasthan under National Hydrology Project (NHP). Conceptualized & implemented a network to support emergency messaging by fisherman while fishing at deep sea. It provides information like weather, PFZ & emergency message broadcast. All subsystems are indigenously developed at SAC. Trip Management System (TMS) software, for facilitating fishermen to declare trip with enhanced monitoring was operationalized. RTATS (Real Time Air Traffic Network Support) terminal performance was verified on RTAT terminals for 10 set of frequencies in specified time slots. As a part of Manpack terminal development, demonstration of flat top man pack terminal in satellite loop completed. Sky Monitor for optical ground station has been installed at Delhi Earth Station (DES) for optical ground station for measurement of atmospheric turbulence and related flight parameters. Total Six (6) nodes for tele-medicine were installed & commissioned for CRPF in North east region.

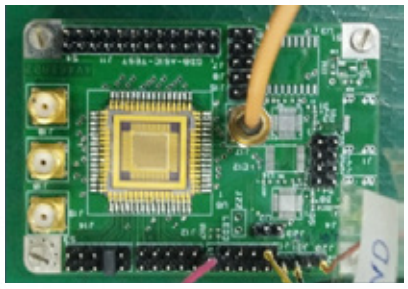


Tele-Medicine Nodes at Kashmir

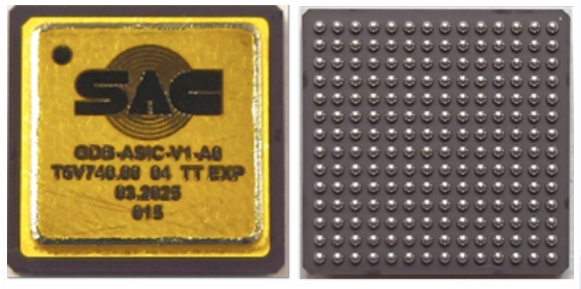
During this period SAC has achieved significant milestones in the development of NavIC receivers. First SSV receiver supporting 4 GNSS (GPS, Galileo, Beidou & NavIC) at Geostationary orbits was realized & delivered for TDS-01. Designed & developed all-in-view 100 Channel NavIC + GNSS Digital Baseband (GDB) ASIC @ 28nm. SAC developed ANGAD (Advanced Navigation Geodetic application device) receiver for Continuously Operating Reference Station (CORS). SAC developed hardware & software modules for Quad band (L1, L2, L5 & S) in-house developed NavIC SPS and RS simulator. ~ 2 mm position accuracy is obtained in FPGA based SPS Receiver in differential mode.



ASIC die (6.5mm x 6.5mm) in CQFP-64 package

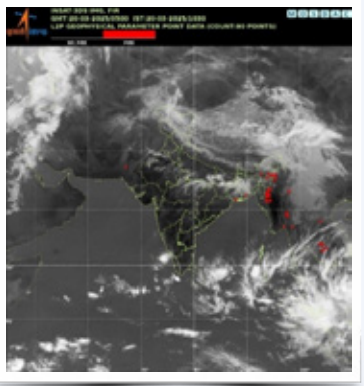


ASIC Test Card



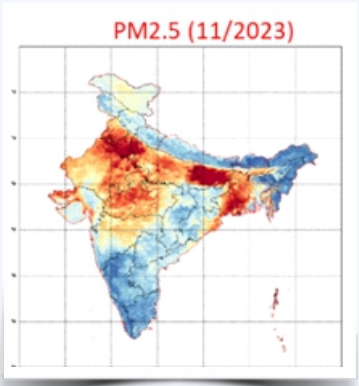
ASIC Ceramic Flip-chip BGA Package Top and Bottom

Earth Observation Applications



The data from earth observation satellites are used for several applications covering Agriculture, Forestry, Terrestrial, Coastal and Marine Environment, Satellite Meteorology, Oceanography, Cryosphere, Geosciences, Hydrology, Marine and Water Resources and so on. Here are the Centre's latest major updates;

SAC/ISRO developed a dedicated MOSDAC-IN web-portal for Indian Navy. With this portal SAC/ISRO has enabled the Indian Navy with satellite data assimilation capabilities for generating weather and ocean outlooks, empowering them to achieve self-reliance in this domain. Integration of module for animation of the satellite data and forecast at Web application MOSDAC-IN as per the requirement of Indian Navy successfully completed. Value added data products were generated under various application programs of SAC and hosted on MOSDAC and VEDAS.



High-resolution PM2.5 & PM10 products have been generated using ML based retrieval from satellite derived AOD & NDVI, which generate instantaneous PM over entire Indian Landmass. Early warning alerts of thunderstorm and lighting products based on INSAT-3DS Nowcast techniques has been developed and pilot study has been done for Bihar lighting strike. Web based potato crop yield estimation has been completed and a prototype website for India Potato crop estimation has been developed. Model-based yield estimates for kharif and rabi rice crops were verified and it improved the national-level yield estimation and support crop insurance efforts. Advanced algorithm development for the improved EOS-06 OCM Chlorophyll-a concentration for the better

identification of Potential Fishing Zone for INCOIS completed. Soyabean yield at state and district level using automated Semi-physical model GEOCREST for 2025-26 were estimated for 9 districts of Rajasthan and was found to vary from 803 kg/ha in Jhalawar district to 1210 kg/ha in Banswara district and data was shared with MoAFW. National level Mangroves atlas showing first of its kind spatially explicit mapping of mangroves at community level was prepared using IRS LISS-4 data of 2019-20 at 1:25,000 scale under DOS funded SHRESTI project.

Chandrayaan-2 DFSAR mosaics with novel parameters for the lunar poles released: DFSAR is the first lunar radar with full-polarimetry capability to study the permanently shadowed regions (PSRs) of the Moon. Around 1400 L-band datasets are processed using in-house algorithms for polarimetric parameters and their mosaics covering 80°-90° N/S of the Moon. As a precursor science study for the upcoming THz telescope at Hanle (Ladakh), a U-Net based ML model is developed for parameter free, automated identification of filaments in the Interstellar medium using Terahertz observations of nearby molecular clouds.

The Raster analytics system for Interactive Data Modelling (RIDAM) is an in-house, indigenously designed and developed solution for near-real-time processing of raster datasets. With a patent application currently under process, RIDAM demonstrates exceptional performance exceeding commercial state-of-the art solutions and pushes forward the idea of “Atmanirbhar Bharat”. State specific thematic portals for Bihar and Ladakh (BODHI and LAMA) has been developed to address unique regional requirements. The BODHI system serves the Government of Bihar by providing critical geospatial datasets and hazard information across sectors like agriculture, hydrology, and drought monitoring to support disaster management and planning. Simultaneously, the LAMA portal caters to the Union Territory of Ladakh with distinct modelling tools tailored for the Himalayan terrain, including high-resolution 3D city models for Leh, detailed solar rooftop assessments, and specialized tracking of snow cover and glacier melt, thereby offering targeted solutions that range from urban expansion analysis to cryosphere monitoring.

Technology development

SAC has taken a leap in conceptualizing, developing and ingesting advanced technologies, with a focused objective of achieving self-reliance in space technologies. Currently, more than 250 TDP/Advanced R&D activities are ongoing within the Centre. SAC has taken initiative for the development of technology programmes like Sub mm-wave/THz Development, LiDAR development, Liquid Crystal (LC) Based Metasurface Antenna, Origami based Antenna, Next-gen TR Modules, Ultra Spectral Resolution GHG Sensor, Indigenous Integrated detector Cooler Assembly (IDCA, Indigenous VNIR Hyperspectral Imaging Sensor, X- band TWTA etc

Some major developments are illustrated below:

- Indigenous Semiconductor technology development: SAC has taken up indigenous development of 250nm process technology for RF GaN HEMT fabrication, where front end unit processes were developed. SAC initiated in-house development of quantum devices like the Quantum Dot based SPS (Single photon Source) & semiconductor SPD (Single photon detector). Quantum systems implementation is currently being done by probabilistic sources made from bulk non-linear crystals.

Research is being done on deterministic sources pursued for higher key rates. In-house development of Photonic ICs (PIC) & Ceramic semiconductor (RF, Digital, Optical) packaging are some of the semiconductor technology initiated by SAC.

- Travelling Wave Tube Amplifier (TWTA) & High voltage EPC: Ku Band TWTA was successfully qualified in 2024. Ka Band & C band 120W TWTA was undergoing qualification.
- Indigenously Developed RAFS (iRAFS): SAC has successfully realized RAFS in-house and successfully inducted in NVS-03. Study was undertaken for the miniaturization of iRAFS with reduction in volume by 50% and mass by 35%.
- Optical & Quantum Communication: 4-node quantum network with one real QKD link demonstrated in lab. Development of Post Quantum Cryptography (PQC) based Key encapsulation and authentication methods in progress. Successfully demonstrated 5W EDFA with input seed -10 dBm at 1550 nm in ambient condition & 2.5W EDFA with input seed -10 dBm at 1550 nm in thermal condition.
- Radar Navigation Sensor: It is the critical technology being developed for precision landers for 3 axis velocity measurement. Crane test of Radar Navigation sensor for four beams completed & results were analysed.
- High Accuracy Impulse Ground Penetrating Radar: Development of impulse GPR with high resolution target detection for future Rover payload (Lupex mission) completed & demonstrated successfully.
- System Design Technology Development for software defined Radio-based (SDR) HTS payload: Due to evolving user demands and emerging market trends, there is a need for the development of a reconfigurable payload, possessing the ability to dynamically modify the coverage, frequency plan and capacity distribution in-orbit. This has led to the development of software-defined payloads which are capable of providing flexibility in terms of power, bandwidth, orbit location & connectivity. A payload demonstrator model was developed with 16-channel transmit and receive chains, using RF and digital subsystems and a 2.1m offset-fed reflector antenna with 16 feed elements.
- Development of SMART Fastener for Deployable Telescope (DT): A hold down and release mechanism (HDRM) based on Shape Memory Alloy (SMA) actuators and breakable titanium fastener is designed, developed, demonstrated and successfully qualified.
- Design & Development of Ku-band SATCOM-On-The-Pause Terminal (SOTP): Successfully integrated and tested Inductive & Diffuse sensors with SOTP terminal for sensing homing of Azimuth, Elevation & polarization axes along with feed boom resting position.

Fabrication and Test Facilities

The facilities at SAC includes highly sophisticated payload integration laboratories, electronic & mechanical fabrication facilities, environmental test facility, image processing, and analysis facilities. Some of the major technology facilities & infrastructure commissioned recently are Li-ion Battery Characterization Test Facility, Cryogenic system for sub-mm wave Telescope, Visible & NIR detector characterization lab, IR & X-ray detector development setup, EMI/EMC test chamber, Human Space flight AIT building & Indigenously developed Compact Antenna Test Range (iCATR).

Systems Reliability

Systems Reliability Area of SAC, is responsible for the formulation and implementation of Quality practices, to ensure that all projects undertaken in the centre, meet the high degree of Quality and consistency that ISRO is recognised for. This is implemented through a comprehensive and all-encompassing Quality programme, covering all aspects of product development that includes multi-tiered design review and approval; careful selection of components and materials which is followed by extensive acceptance testing; thorough qualification of fabrication processes along-with stringent Quality Control followed by comprehensive characterisation of the developed product through a rigorous Test and Evaluation. Each of these activities are regularly monitored through Audits. The quality programme and practices are implemented not only within the centre, but at sub-contractor's facilities as well.

Capacity Building & Outreach Programme

SAC objectives are realized and met with a well-planned strategy for a sustained capacity building through skilled human resources, establishment of state-of-the-art facilities, industry and academia participation and international cooperation under a well-defined policy support of ISRO.

Vikram Sarabhai Space exhibition (VSSE) at SAC campus conducted in-house, mobile and virtual exhibitions for students of different educational institutes, to spread awareness about ISRO and SAC activities. SAC continued support to Indian industry for capacity building. State-of-the-art SAC infrastructure for testing is being offered to NGEs through IN-SPACe, NSIL, Government organizations and academia. Facilities like EMI-EMC, CATF, and Thermovac are being utilized. Besides, SAC continued imparting training and certifying manpower from industry. Industry Meets were also conducted periodically to sensitize Industries about potential technologies and their applications.

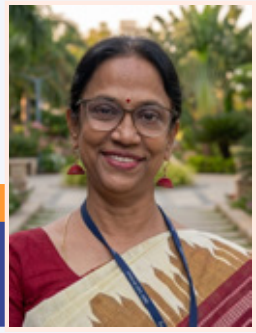
SAC took a lead role with active research coordination for more than 500 In-house and Sponsored Research under various avenues like TDP/Adv. R&D, RESPOND, RESPOND Basket, Space Technology Cells (STC), Regional Academic Centres for Space (RAC-S), Space Technology Incubation Centres (S-TIC), and Research Management. The projects were periodically reviewed under various programs including Annual Sponsored reseArch Review (SAC-ASAR). SAC has been proactively enhancing and upgrading the skills and competencies of internal human resource through standard as well as tailored training and development programs including SAC Lecture & Knowledge Sharing series, non-training interventions such as conferences, seminars, workshops at national as well as international levels.

The Centre also conducts courses for students from the Asia Pacific region under the aegis of Centre for Space Science and Technology Education in Asia and Pacific (CSSTEAP) affiliated to United Nations. The courses of SATMET-14 & SAS-14 has commenced from August 01, 2025 at SAC Bopal Campus for 9 months. Total 18 participants from different Asia Pacific countries are participating in the Course. The first CSSTEAP short course on 'Environmental pollution Monitoring through satellite observation and advanced modelling' was recently conducted.

Future Outlook

SAC is instrumental in developing the essential technologies required for the societal benefits. Looking in to present Scenario, India's Space technology is also focusing on reusability (RLV-TD), Space Station (BAS) & fostering private sector. Gaganyaan is the first human space flight programme of ISRO and its objective is to demonstrate indigenous capability of human space flight to Low Earth Orbit.

SAC has undertaken many technology developments programmes like Optical & Quantum Communication, Quantum devices, Hyperspectral imaging, focus on the development of space technology which strengthen Indian Space Economy. SAC is also working on several advanced TDPs to make 100% indigenous Payloads. SAC is developing High Throughput Satellites (HTS) that provide greater data transmission capacity to meet the high demand of the users. SAC is already working on the development of second generation navigation satellites to augment NavIC constellation with improved accuracy & new technology elements. SAC is also working on payloads of Space based Surveillance (SBS-3) mission, which is a series of programme undertaken by Government of India to deploy advanced surveillance satellites for enhanced land & maritime surveillance. ISRO shall develop 21 satellites. In the applications front, major initiatives includes the conceptualization of satellite data for the development of agriculture, disaster management, weather forecasting, urban development etc.



CSSTEAP Course on Satellite Meteorology and Global Climate, at SAC, Ahmedabad (SATMET- 14)

Dr. Sasmita Chaurasia
Course Director, CSSTEAP SATMET-14

The 14th Post Graduate Course on Satellite Meteorology and Global Climate (SATMET-14) was conducted at Space Applications Centre,ISRO, Ahmedabad under the aegis of CSSTEAP, a UN-affiliated organization. The nine-month course was designed to train meteorologists, forecasters, and academia from the Asia-Pacific region, enabling them to impart advanced knowledge of satellite meteorology and global climate to other officers in their respective countries once they go back.The duration of the course is August 01, 2025 to April 30, 2026.Ten participants from six countries i.e. Bangladesh, Ethiopia, Maldives, Mongolia, Papua New Guinea, and India attended the course.

The joint inaugural function for (i) Satellite Meteorology and Global climate (SATMET-14) conducted by Space Applications Centre (SAC) and (ii) the Space and Atmospheric Science course (SAS-14), conducted by the Physical Research Laboratory (PRL), was held on September 02, 2025, at K. R. Ramanathan Auditorium of PRL. Shri Nilesh M. Desai (Director, SAC), Dr. Anil Bhardwaj (Director, PRL), and senior officials from both institutions graced the occasion.

Group photo of joint inaugural function held on September 02, 2025 at PRL Ahmedabad.

The Director of SAC presented an overview of SAC's activities and its unique contributions in terms of Satellite Payload Development, Data Processing and different applications of Satellite Data giving insights into operational and research aspects of satellite meteorology.

Interaction with Director, SAC and other senior SAC scientists

The SATMET-14 course which is of 9 months' duration is comprised of 2 semesters spread in 3-modules. The 1st module covers the fundamentals of Satellite Meteorology and Global climate, and 2nd module deals with Advanced Concept of Satellite Meteorology, e.g., Geophysical Parameter Retrieval and Satellite Data Products and their application in Numerical Weather Prediction (NWP) etc. In the first two modules, everyday in the morning session lectures were delivered by the subject experts followed by practical in the afternoon session. In the 3rd module, called the pilot project module (of 3 months' duration), the participants carried out project on a topic relevant to their own country under the guidance of an expert scientist from Space Applications Centre, Ahmedabad.

The performance of the participants was assessed through written, interactive sessions and practical exercises, tests & examinations. Each participant gave number of seminars during the course, related to climate and weather of their country. A weekly weather discussion over Indian and the Asia-Pacific region using satellite images, weather charts and model forecasts available from various sources was conducted during the first three months. This gave them a good exposure to various web sites providing operational satellite data, forecasts and also helped them to keep track of various important meteorological events over their own region. The active south-west monsoon conditions over India and Gujarat, in particular, gave a good feel of heavy monsoon spells to the participants and made the weather discussions very educative, informative and lively. In the next 3 months discussion was carried out related to some important topics affecting different countries and globally related to different weather events and climate change. Feedback was given to each participant and the presentation was evaluated. This helped them to prepare for the presentation for their pilot project. They also got an excellent exposure to working with numbers during the tutorial sessions where a number of simple, yet conceptual problems were discussed and solved in the class.

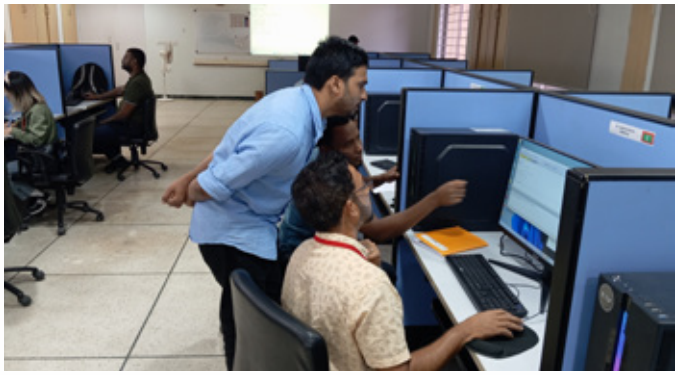
The candidates were assigned to undertake a pilot project which is relevant to their organisation/country. During the 3 months pilot-project they learnt different skills like the formulation of a problem of relevance to their country, specifying and acquiring data, execution, and communication both orally and in writing. The pilot project was evaluated by an expert committee.

Inside the classroom

Faculty members for this course were mostly from the Atmospheric and Oceanic Sciences Group (AOSG), EPSA, SAC, Ahmadabad. A few scientists from other Groups and Areas of Space Applications Centre (SAC), Indian Institute of Remote Sensing (IIRS), Dehradun, Physical Research Laboratory (PRL), Ahmadabad, India Meteorological Department (IMD) and Andhra University have also delivered lectures.

SATMET-14 course was held in the spacious SAC (Bopal) Campus. The lectures were recorded and made available to participants for revising the lectures in office. The lecture notes by the faculties were shared to the participants both in printed and digital form, which enabled them to prepare for the examinations.

A special SATMET Laboratory with modular structure, uninterrupted power supply and networking was commissioned for the course with twenty four PC's and a Server. This facilitated easy access to various satellite datasets, software etc. to each participant, particularly during their three months pilot project phase. Versatile software package Python, Matlab etc. on each terminal provided much needed standardization in data processing (INSAT-3D/3DR/3DS, MeghaTropique, SCATSAT-1, NOAA, MODIS etc.) to all the participants. They were given access to internet in the same lab during the office hours, which helped them to download reading materials as well as data required for the project work.



Inside the Computer Lab

For the first time the participants attended a specialized course on Space Law combined with SAS-14 and RS&GIS participants at IIRS, Dehradun. The course covered lectures in different aspects of Space Law as well the participants were evaluated based on group project work related to different topics.

They also visited different labs and facilities, not only of the parent institution (SAC) but also other research institute like Physical Research Laboratory (PRL), IMD Delhi, NRSC & INCOIS, Hyderabad, IIT Chennai, IIRS Dehradun etc. They visited the launch pad at SDSC, Sriharikota and had interaction with the scientists which helped them to know about the nature of weather forecasting required during the time of launch as the participants are mostly operational forecaster of their country.

Visit to PLASIV facility of SAC

Interaction with Dr Ravi Chandran, Secretary, Ministry of Earth Sciences, during visit to IMD, Delhi

With Associate Director, and Scientists during visit to NRSC, Hyderabad

Visit to INCOIS Hyderabad

VISIT to SDSC, Sriharikota

Participants visited Department of Ocean Engineering, IIT Madras

They also visited few unique places of India, like the Taj Mahal & Agra Fort in Agra; Humayun Tomb & India Gate, New Delhi; Ramoji Film City & Charminar at Hyderabad etc.

The participants also participated in the Pearl Jubilee Celebration of CSSTEAP commemorating the completion of 30 years at IIRS, Dehradun. This not only gave the participants to interact with stalwarts of ISRO but also they got the opportunity to interact with the alumni of SATMET and other courses.

At Pearl Jubilee celebration of CSSTEAP on 16 February, 2026 with Rear Adm Rambabu (SATMET Alumini)

SATMET-14 participants visited Taj Mahal at Agra

SATMET-14 participants visited Agra Fort

Hostel accommodation was arranged for the participants in the International hostel with good living facilities and with attached kitchenette. Canteen facility was provided to the participants in both SAC campus and hostel. For entertainment, DTH system was provided to them in their rooms. WiFi connection is provided in the hostel which also helped them in downloading the data for work and browsing. The participants used the recreation and gym facilities made available in the hostel area. Centre also provided medical facilities for minor ailments. There were no major health problems reported by the participants during the nine-month course.

To break the monotony of academic activity, the participants also visited different places in an around Ahmedabad like the riverfront, Kankaria Lake, Gandhi Ashram etc.

Enjoying the World Heritage City (Ahmadabad)

It has been possible to conduct the 14th PG course on Satellite Meteorology and Global Climate at SAC, Ahmedabad due to sincere and dedicated efforts put in by a large number of persons at SAC. We would particularly like to thank all faculty members, focal points and project guides, who in spite of their busy schedule delivered lectures, organized practical sessions, conducted tutorials and provided guidance to the participants for their project related activities. We thank SAC administration, SAC-Bopal campus administration, Controller SAC, Group Director CMG and his team, Senior Purchase Officer and his team, Head Accounts/IFA SAC and his team, P & PR, Medical Officer and other administrative staffs for the support extended to the course participants. The support extended by CSSTEAP HQ Administrative staff, Program Coordinator Dr Arijit Roy needs special acknowledgement. We thank Dr. V. Narayanan Chairman ISRO, and Shri N M Desai, Director SAC for all the support and encouragement in organizing the course satisfactorily fulfilling the commitments of SAC in conducting the SATMET course on behalf of CSSTEAP. We sincerely thank Director, CSSTEAP for his keen interest and support in making this course a great success.

COURSE AT A GLANCE

Module 1 :
Fundamentals of Meteorology, Climatology and Remote Sensing (Three Months)

Module 1.1	**Concepts in Meteorology and Climatology**
Section 1 -1 MET	Basic concepts of Meteorology, Climatology and Oceanography
Section 1 -1 MATH	Mathematical and Computational Techniques for Satellite Meteorology
Module 1.2	**Concepts in Satellite Meteorology**
Section 1-2 SM	Principles of Meteorological Remote Sensing
Section 1-2 MSI	Overview of Meteorological Satellites / Orbits
Module 1.3	**Image Processing, Interpretation and GIS**
Section 1-3 DIP	Image Processing Techniques and Geographic Information System (GIS)
Section 1-3- WF	Image Interpretation in Meteorology and Weather Forecasting

Module 2 :
Advance Concepts and Techniques in Satellite Meteorology and Global Climate (Three Months)

Module 2.1	**Geophysical Parameter Retrieval**
Section 2-1 AP	R T Theory, Atmospheric Parameters
Section 2-1 LOP	Land and Oceanic Parameters
Module 2.2	**Applications of Satellite Derived Parameters**
Section 2-2 -AWF	Applications in Meteorology and Weather Forecasting
Section 2-2 -NM	Satellite Data Assimilation in Numerical Models
Module 2.3	**Global Climate and Environment**
Section 2-3- SC	Short Term Climate Variabiltiy
Section 2-3- LC	Long Term Climate Change
Section 2-3-ESI	Environment Issues and Societal Impacts

Module 3 : PILOT PROJECTS (Three Months)

Break - up of Module 1 & 2 Lectures

Sub- MODULE 1.1 : CONCEPTS IN METEOROLOGY AND CLIMATOLOGY

Section 1-1-MET : Basics Concepts of Meteorology, Climatology & Oceanography
❖ Atmospheric, Dynamics & Physical Meteorology
❖ Extra Tropical Weather Systems
❖ Tropical Weather Systems, Monsoon
❖ Climate of Asia-Pacific region and Variability
❖ Ocean and Climate

Section 1-1-MATH : Mathematical, Statistical Techniques and Programming Fundamentals
❖ Matrices & Vectors
❖ Partial & Total differential equation
❖ Integral & Derivatives
❖ Basic Concepts of Statistics
❖ Basics of Computer Programming

Sub- MODULE 1.2 : CONCEPTS IN SATELLITE METEOROOGY

Section 1-2-SM : Basic Concepts of Satellite Meteorology
❖ Principles of Remote Sensing
❖ Characteristics of Electromagnetic Radiation
❖ Passive Remote Sensing
❖ Active Remote Sensing
❖ Parameter Retrieval & Validation

Section 1-2-MSI : Overview of Meteorological Satellites / Orbits
❖ Orbits and Navigation
❖ Operational Polor-orbiting Satellites
❖ Operational Geostationary Satellites
❖ Other Satellites
❖ Satellite data Archive

Sub - MODULE 1.3 : Basic Concepts of Satellite Data Processing and Analysis

Section 1-3-SDP : Satellite Data Processing
❖ Map Projection
❖ Satellite Positioning System
❖ Image Registration, Radiometric & Geometric Correction
❖ Image Classification
❖ GIS

Section 1-3-ANA : Remote Sensing Data Analysis and Interpretation
❖ Satellite Imagery
❖ Spectral Properties
❖ Identification of Mesoscale Systems
❖ Tropical Synoptic Systems
❖ Extra Tropical Synoptic Systems

Sub Module 2.1 : GEOPHYSICAL PARAMETER RETRIEVAL

Section 2-1-AP : R T Theory and Atmospheric Parameters
❖ Winds
❖ Temperature Profile
❖ Humidity Profile
❖ Precipitation
❖ OLR
❖ Clouds and aerosols

Section 2-1 LOP : Land and Oceanic Parameters
❖ Sea Surface Temperature
❖ Sea Surface Winds
❖ Vegetation Index
❖ Land Surface Parameters

Sub-MODULE 2.2 : APPLICATIONS OF SATELLITE DERIVED PARAMETERS

Section 2-2-AWF : Satellite data applications in Weather and Climate
❖ Onset of Monsoon
❖ Intra-Seasonal & Inter annual variability
❖ Tropical Cyclones
❖ Extra Tropical Cyclones
❖ Weather Systems related to Tropics & Mid-latitude interaction
❖ Agrometeorological Applications
❖ Air-Sea Interaction

Section 2-2-NM : Numerical Models and Satellite Data Assimilation
❖ Atmospheric Models
❖ Concepts of Data Assimilation
❖ Satellite Data Assimilation
❖ Impact of Satellite Data Assimilation

Sub-MODULE 2.3 : GLOBAL CLIMATE AND ENVIRONMENT

Section 2-3-SLC : Essensial Climate Variables and Climate Change	Section2-3-ESI : Extreme weather events and meteorological disasters
❖ El-Nino & Southern Oscillation	❖ Climate Change
❖ Cloud Climatology	❖ Geosphere – Biosphere interaction
❖ Land Surface Changes	❖ Green House Effect & Global Warming
❖ Radiation Budget	❖ Hydrological Cycle
❖ Ozone and other Trace Gases	❖ Changes in Cryosphere
❖ General Circulation Models & Regional Circulation Models	❖ Air Pollution
	❖ Disaster Management
	❖ Future Climate Scenario & Satellite Missions

LIST OF PRACTICALS

Module I : Operational Meteorological Satellite Data Handling & Applications	
Sr.No.	**Title**
1	Computer Orientation I: Familiarization of SATMET Labs, systems & networks,
2	Familiarisation to MOSDAC
3	Computer Orientation II: Visualisation tools using LINUX, FORTRAN, Python and Matlab etc.
4	Basic satellite data handling using Python and RGB generation, Visualization & analysis of Meteorological Data
5	Meteorological Data Processing
6	Application of scatterometer data in meteorology
7	Applications of satellite data in tropical cyclones

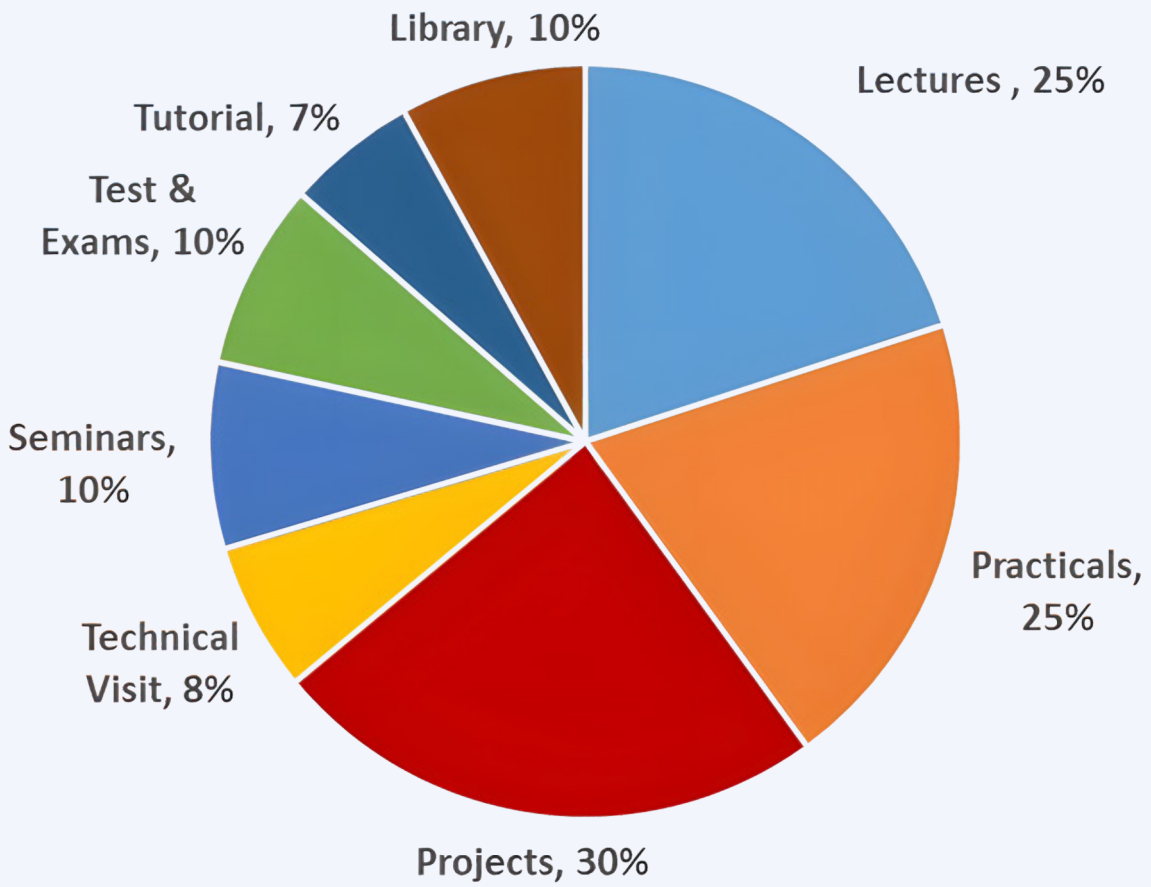
Module II: Remote Sensing of Geophysical Parameters & Numerical Modelling Applications	
Sr.No.	**Title**
1	Basic retrieval techniques
2	Retrievals from microwave instruments
3	Retrieval of temperature & humidity profile using sounder observations
4	SST retrieval
5	Retrieval of Cloud Motion
6	Satellite based now casting of weather systems
7	WRF installation and Demo
8	Assimilation of satellite data using NWP model

Course Director : Dr. Sasmita Chaurasia

Focal Person-Pilot Projects : Dr. P. K. Thapliyal

BREAK UP OF COURSE HOURS

BREAK UP OF COURSE HOURS (SATMET-14)



LIST OF FACULTY MEMBERS

SAC	
No.	**Name**
1	Mr. Abhishek Chhari
2	Dr. Abhishek Chakraborty
3	Mr. Aman Waheed Khan
4	Mr. Anup Mandal
5	Dr. Bimal Bhattacharya
6	Dr. Bipasha Paul Shukla
7	Mr. Devang Mankad
8	Dr. Dhani Ram Rajak
9	Mr. Ghansham Sangar
10	Mr. Jagadamba Prasad Singh
11	Dr. Jai Kumar
12	Mr. Jignesh Kshatriya
13	Mr.Jishad M
14	Mr. K F Muhammed
15	Dr. K N Babu
16	Mr. Maganti Srinivasa Tarun
17	Dr. Manoj Mishra, AOSG
18	Dr. Manoj Mishra, ATVG
19	Dr. Mehul R Pandya
20	Dr. Munn Vinayak Shukla
21	Mr. Naveen Tripathi
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23	Dr. Neerja Sharma
24	Dr. Neeru Jaiswal
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26	Dr. P. K. Thapliyal
27	Ms. Pallavi V Sridhar
28	Dr. Prashant Kumar
29	Mr. Prateek Sharma
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31	Ms. Purvee Joshi
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36	Mr. Ravikamal Choudhary
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40	Mr. S K Sazid Mahammad
41	Dr. Sanjib K Deb
42	Dr. Sasmita Chaurasia
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45	Ms. Shivani Shah
46	Dr. Suchandra A Bhowmick
47	Dr. Sukanta Das
48	Dr. Sushil K Singh
49	Mr. Vishal I Sakarvadiya

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6	Dr. Ramchandran, PRL
7	Dr. Somkumar Sharma, PRL
8	Dr. V. Sathiyamoorthy, SPL

Outside DOS, India	
No.	**Name**
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2	Dr. Hasibur Rahaman, INCOIS, Hyderabad
3	Prof. P. Suneetha, Andhra University
4	Dr. V R Durai, IMD, Chennai

LIST OF PARTICIPANTS AND THEIR ORGANISATION

Sr.No.	Name	Organisation
1	**Mr. Md. Hasanul Banna**	Bangladesh Meteorological Department **Bangladesh**
2	**Mr. Md. Zoynal Abedin**	Bangladesh Meteorological Department **Bangladesh**
3	**Mr. Tesfay Ljalem Weldeslassie**	Samara University **Ethiopia**
4	**Cdr. Anish Kumar**	Indian Navy **India**
5	**Sqn Ldr. R. Arun**	Indian Air Force **India**
6	**Cdr. DSV Sagar Varma**	Indian Navy **India**
7	**Mr. Abdulla Naeem**	Maldives Meteorological Services, **Maldives**
8	**Ms. Tugsjargal Oldogch**	Aviation Meteorological Center of National Agency for Meteorology and Environmental Monitoring of Mongolia **Mongolia**
9	**Ms. Urantsetseg Batmunkh**	Center for Hydrometeorology and Environment of Khuvsgul Province **Mongolia**
10	**Mr. Bomil Jackson Alesana**	Department of Transport, National Weather Services **Papua New Guinea**

Participants Profile and Pilot Project

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Md. Hasanul Banna was born into a Muslim aristocratic family in Ashashuni Upazila of Satkhira district, the southernmost district of Bangladesh, located on the edge of the Sundarbans, the world's largest mangrove forest. He spent his childhood and adolescence in Khulna, the industrial city of Bangladesh.

He began an extraordinary journey after joining the Bangladesh Meteorological Department in January 2014. Before joining the Bangladesh Meteorological Department, he earned his bachelor's and master's degrees in mathematics from the National University of Bangladesh.

He is a tree lover and likes to plant trees and plants them at different times. He likes to play cricket and football. He is calm, dedicated, and self-confident. He values self-reliance.

Mr. Md.Hasanul Banna
Meteorological Assistant

Guide: **Mr. Ravi Kamal Choudhary**
Sci/Eng.-SE,
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Abstract

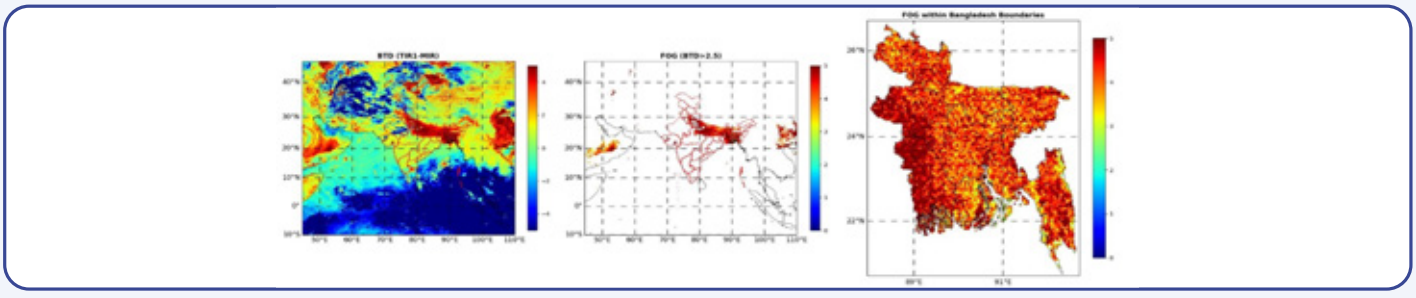
Night Time Fog Detection over Bangladesh Using Geostationary Satellite.

Night-time fog is a recurrent meteorological phenomenon over Bangladesh during the winter season (December-February), often leading to significant disruptions in aviation, road transport, inland waterways, and agricultural operations. Detection of fog during night-time is particularly challenging due to the absence of solar illumination, which limits the applicability of visible and near-infrared channels. Therefore, thermal infrared observations from geostationary satellites provide a reliable alternative for continuous monitoring of fog events. In this study, INSAT-3DS Imager observations are utilized to detect and monitor night-time fog over Bangladesh with high temporal resolution.

The methodology involves reading count data and corresponding brightness temperature (BT) lookup tables for the Thermal Infrared (TIR1, 10.8 μm) and Mid-Infrared (MIR, 3.8 μm) channels from INSAT-3DS Imager Level-1C ASIA MER HDF5 products. The count values are converted to BT using band-specific lookup tables available within the HDF5. Subsequently, the Brightness Temperature Difference (BTD) between TIR1 and MIR channels is computed to enhance the detection of low-level fog and stratus clouds. A dual-threshold approach is applied, wherein TIR1 brightness temperature less than 270 K is used to filter out cold high-altitude clouds, followed by a BTD threshold of less than 2.5 K to discriminate fog and low-level stratus from underlying land and water surfaces. Preliminary results demonstrate that the BTD threshold successfully captures the spatial extent of the advection fog common over the Indo-Gangetic Plain and its encroachment into the Bangladesh.

To spatially constrain the detected fog, continent boundary shape file is overlaid on the derived fog mask generated from the ASIA MER domain. The Bangladesh region is extracted using the country shape file, enabling focused monitoring of fog occurrences within the national boundary. The resulting outputs provide a localized and operationally useful fog monitoring product for Bangladesh, supporting improved situational awareness and potential early warning applications.

Keywords: Night-time Fog, INSAT-3DS, TIR1, MIR, BT, BTD, Night-time Fog monitoring.



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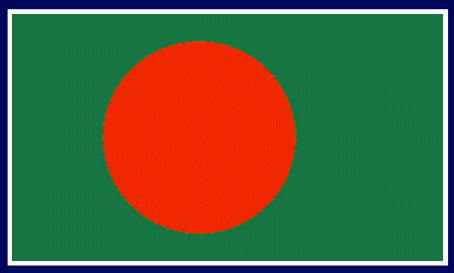
If you ever find yourself wandering through the building of Bangladesh Meteorological Department, you'll likely hear the name Md. Zoynal Abedin spoken with a great deal of warmth and respect.

Zoynal's journey into the world of science began at the University of Rajshahi, where he dove deep into the mysteries of the earth, completing his B.Sc. in Geology and Mining in 1996 and his M.Sc. just two years later. Since joining the Meteorological Department in 2001, he hasn't just been tracking the weather—he's been setting the standard for what it means to be a true professional.

What makes Zoynal stand out isn't just his impressive technical knowledge; it's the way he carries himself. Here's why he is a favorite among colleagues and peers: Known for his honesty and "unwavering dedication," he's the kind of person who does the right thing even when no one is watching.



Mr. Md. Zoynal Abedin
Meteorological Assistant

Guide: **(1) Dr. Bimal K. Bhattacharya**
Sci/Eng.-G, EPSA-AESG
(2) Mr. Jagadamba Prasad Singh
Sci/Eng.-SG, EPSA-AESG-PACD

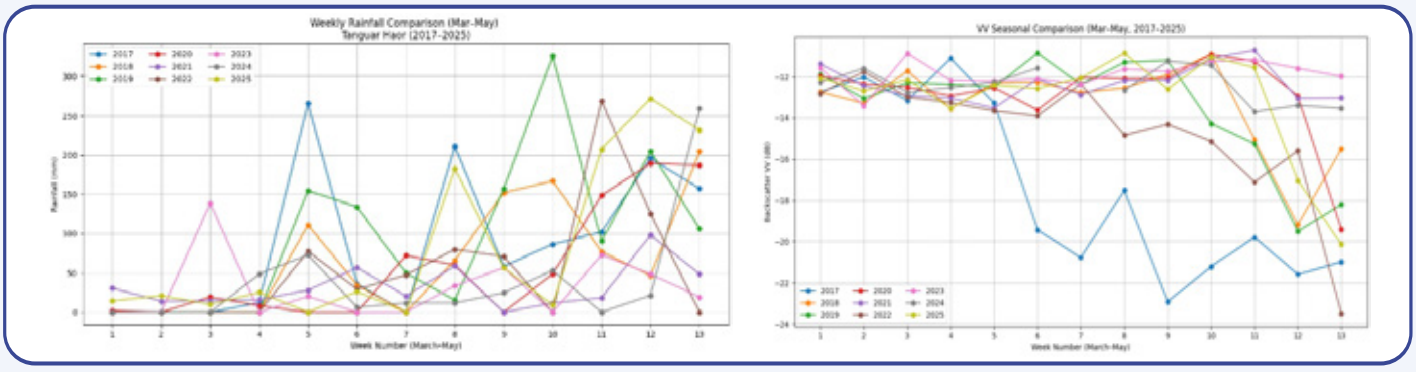
Abstract

Assessment of Agricultural losses due to flash Flood in Tanguar Haor, the north -eastern part of Bangladesh.

Flash floods pose a recurrent and devastating threat to haor-based agricultural systems in north-eastern Bangladesh, particularly to pre-harvest Boro rice cultivation, which constitutes the primary livelihood of the region. This study assesses flash flood–induced agricultural losses in Sunamganj District using an integrated multi-sensor remote sensing and hydro-meteorological framework. Multi-temporal Sentinel-1 Synthetic Aperture Radar (SAR) data were employed to delineate flood inundation under persistent cloud-covered conditions through VV and VH backscatter thresholding techniques. Complementary Sentinel-2 optical imagery was utilized to derive vegetation and moisture indices, including NDVI and LSWI, to evaluate crop health dynamics, surface water expansion, and moisture stress before and after flood events.

Weekly rainfall data from March to May (2017–2025) were analyzed to examine precipitation variability, detect extreme rainfall anomalies, and establish hydro-meteorological linkages with flash flood initiation. The findings demonstrate that anomalously high weekly rainfall during late April and early May strongly corresponds with rapid flood expansion and substantial declines in NDVI values across croplands. Years characterized by intense rainfall spikes experienced earlier flood onset, prolonged inundation duration, and greater spatial flood extent, resulting in higher agricultural vulnerability.

Change detection analysis reveals significant vegetation degradation and increased surface moisture signatures in affected fields following flood events. The integration of rainfall trend analysis with SAR-based flood mapping enhances threshold identification for flash flood forecasting and strengthens early warning systems. The proposed framework provides a robust, near-real-time approach for flood monitoring, agricultural loss estimation, and climate-resilient planning in vulnerable haor ecosystems under increasing hydro-climatic variability.



Mr. Tesfay Ljalem Weldeslassie
Ethiopia

In the lecture halls of Samara University, there is a face synonymous with both rigorous academic standards and an infectious passion for the stars. Tesfay Ljalem Weldeslassie, born on the first of May in 1990, has spent the better part of the last decade transforming the way his students view the physical world. As a Lecturer in the Physics Department since 2012, Tesfay has earned a reputation that precedes him. He isn't just a teacher; he is a mentor, a researcher, and a collaborator who believes that the pursuit of knowledge is a collective journey. His journey began at Samara University, where he earned his B.Sc. in Physics in 2011.

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Eager to bridge the gap between theoretical principles and modern technology, he moved on to Haramaya University, completing an M.Sc. in Computational Physics in 2017. His academic appetite, however, was not confined to his home borders. In 2022, Tesfay traveled to India at Physical Research Laboratory (PRL), where he earned a Postgraduate Diploma in Space and Atmospheric Science. This international experience added a global dimension to his expertise, blending the intricacies of atmospheric physics with the vast potential of space exploration. Now, as fate would have it he is a part of the elite SATMET -14 course for further honing his skills. While his resume is decorated with high-level certifications, those who work alongside Tesfay speak most highly of his character. By combining his deep roots in computational physics with his recent forays into space science and Satellite Meteorology, he is uniquely positioned to lead his department into a new era of discovery. For Tesfay Ljalem Weldeslassie, the sky isn't the limit—it's just the beginning of the next lesson.

Mr. Tesfay Ljalem Weldeslassie
Lecturer

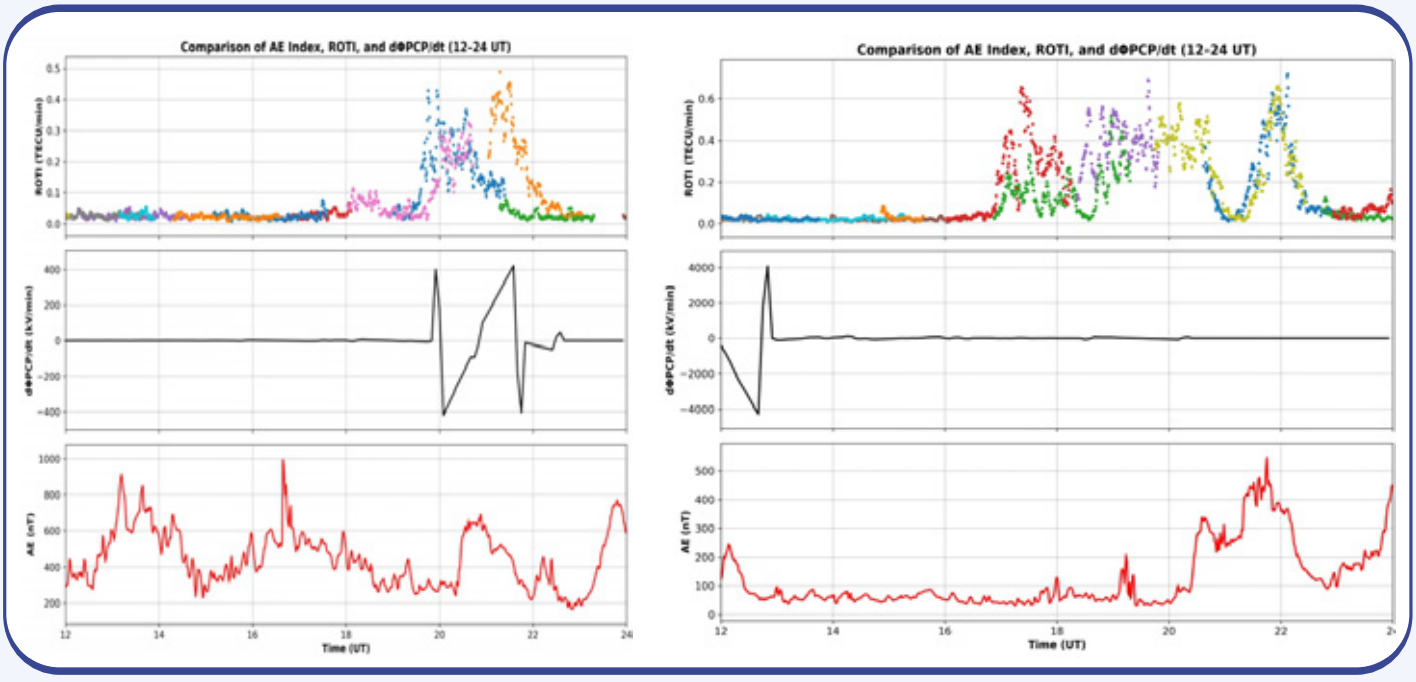
Guide: **Dr. Rajat Acharya**
Sci/Eng.-SG
SSAA-NTAG-NAD

Abstract

Relation between Space Weather condition and Ionospheric Scintillation over Ethiopia

This study investigates the influence of space weather on ionospheric scintillation over Ethiopia using Global Navigation Satellite System (GNSS) data, space weather data and geomagnetic indices. The analysis focuses on the equinox periods of 2023 and 2024, when solar activity was at its maximum. The space weather conditions were observed through the Polar Cap Potential (Φ_{PCP}) index and its rate of change ($d\Phi_{PCP}/dt$). The Auroral electrojet AE index is also observed. These parameters represent the unbalanced electric field due to the magnetospheric convection. GNSS observations from Addis Ababa are used to derive Total Electron Content (TEC), its rate of change (ROT), and the Rate of TEC Index (ROTI). The ROTI is used as a proxy to monitor ionospheric scintillation. Particularly the late nighttime scintillation was observed.

The results show that abrupt change in $d\Phi_{PCP}/dt$, is very closely associated with enhanced ROTI during late nighttime, indicating stronger ionospheric irregularities. Sudden and rapid enhancement in AE is also closely linked to sudden increases in ROTI. These observations highlight the role of dynamic magnetospheric convection in defining the equatorial ionospheric scintillation. However, a few exceptions were also observed. Overall, the findings demonstrate that the space weather processes have a dominant control over the late-night ionospheric scintillation over Ethiopia. These pertinent space weather variations therefore can be good candidates in further researches for predicting the scintillation over Ethiopia This is an important implication for satellite navigation systems.



(a) Late night scintillation due to change in $d\Phi_{PCP}/dt$ *(b) Late night scintillation due to change in Ae*

Cdr Anish Kumar
India

They say that smooth seas never made a skilled sailor, but for Commander Anish Kumar, the journey to the deck of Ship began far from the ocean's reach. Born and raised in the quiet city of Hajipur, Bihar, Cdr Anish's story is a powerful testament to how far grit, hard work, and a clear vision can take you. Growing up in a remote area with a humble background, Anish completed his senior secondary schooling in his hometown. He moved on to pursue his engineering degree from the West Bengal University of Technology, graduating in 2011. Like many bright engineers of his cohort, his talent was immediately recognized by the corporate world. He secured a placement with the MNC, L&T Infotech, where he spent a few months navigating the world of software and systems. However, a bigger calling was on the horizon. In July 2011, the trajectory of his life changed forever. Trading his corporate attire for the prestigious White Uniform, Anish joined the Indian Navy. This wasn't just a career move; it was the commencement of a journey defined by discipline and service to the nation. Over the last fifteen years, Cdr Anish has consistently proved his mettle. His career is a mosaic of challenging assignments and high-stakes operations. Some of the standout chapters of his service include: Serving onboard the Aircraft Carrier Vikramaditya, a role that demands precision and nerves of steel. Stepping into a joint-service environment at the Air Force Academy, Hyderabad, where he has been instrumental in shaping the next generation of officers, sharing the wisdom gained from his years at sea. Today, as he continues to excel in his service, he remains a proud representative of his roots and a stalwart guardian of our waters.

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The Commanding Officer

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Cdr Anish Kumar
Directing Staff

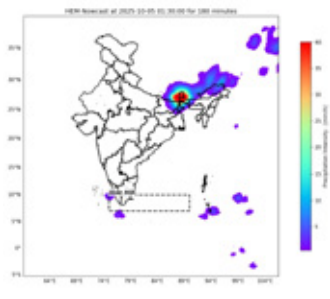
Guide : **Mr Abhishek Chhari**
Sci/Eng.-SE
EPSA-AOSG-ASD

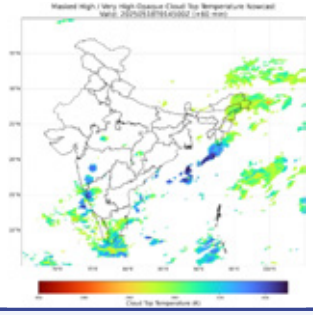
Abstract

WEATHER NOWCASTING APPLICATION FOR NAVAL OPERATIONS

The rapid evolution and movement of convective weather systems present significant challenges to naval operations, where timely and accurate atmospheric information is critical for mission safety and decision-making. These systems often develop and intensify within short time scales, making conventional forecasting approaches insufficient for real-time operational needs. In such environments, reliance on ground-based observational networks is inherently limited due to sparse coverage over oceans and restricted deployment capabilities. As a result, satellite-based nowcasting, which provides continuous, wide-area monitoring with high temporal resolution, becomes an essential tool for enhancing situational awareness in maritime operations. To address these challenges, this study presents the development of a comprehensive User Interface (UI)-based nowcasting application specifically designed for naval operations. By integrating high-resolution satellite observations with advanced computational frameworks, the application provides a set of five functional modules to support real-time monitoring and short-term prediction of weather phenomena. The first module employs the PySTEPS framework in conjunction with INSAT-3DS Hydro-Estimator Method (HEM) data to generate rainfall nowcasts for up to six time steps (180 minutes). In addition to forecasting, it incorporates a dynamic time-series capability that analyses past rainfall patterns to estimate future accumulation and fractional cloud coverage over user-defined regions, thereby enabling localized assessment of precipitation trends. Building on precipitation analysis, the second and third modules focus on cloud characterization and its evolution. These modules utilize NWCSAF Cloud Type (CT) and Cloud Top Temperature and Height (CTTH) products to identify, visualize, and nowcast operationally significant cloud types. The intensity and development of these clouds are inferred using cloud-top cooling characteristics, allowing for improved tracking of convective growth over six forecast timesteps. To further enhance early warning capabilities, the fourth module incorporates Convective Initiation (CI) products to provide probabilistic forecasts of storm development for 60- and 90-minute lead times. Regions with high likelihood (>75%) are highlighted using a 10 km buffer, enabling operators to quickly identify areas of potential risk. Complementing this, the fifth module integrates Rapid Developing Thunderstorm (RDT) data to detect, track, and nowcast convective cells, offering a focused assessment of storm evolution over a 60-minute horizon. This module provides insights into storm lifecycle and movement, which are critical for tactical decision-making. By systematically combining these diverse meteorological components—ranging from precipitation evolution and cloud dynamics to storm initiation and tracking—the application functions as a unified decision-support system. It enables naval operators to determine whether an area is currently affected by adverse weather, assess the expected intensity and duration of such conditions, and evaluate the likelihood of new storm development. This integrated capability significantly enhances operational safety, improves planning efficiency, and supports more informed decision-making in maritime environments.

Keyword: PySTEPS, Nowcasting,INSAT3DS, NWCSAF,HEM, Cloud Type





Sqn Ldr R Arun
India

Arun hails from Thiruvananthapuram, the vibrant capital city of Kerala, growing up in a city known for its rich culture and academic heritage. He pursued his higher education from the University of Kerala, where he completed his Bachelor's degree in Mathematics and later earned a postgraduate degree in Statistics in 2012.

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Soon after completing his studies, Arun joined the Indian Airforce and got commissioned in Meteorology branch in 2014. Over the past eleven years, he has been actively involved in operational meteorology, serving as a forecaster in several units. . Among his assignments was an instructional tenure at the Navigation Training School, where he contributed to training and guiding personnel in meteorological aspects relevant to operations.

Arun enjoys accepting challenging tasks . He believes in completing assigned tasks on time while maintaining enthusiasm and a positive approach.

Outside his professional commitments, he is passionate about cricket and enjoys playing the sport.

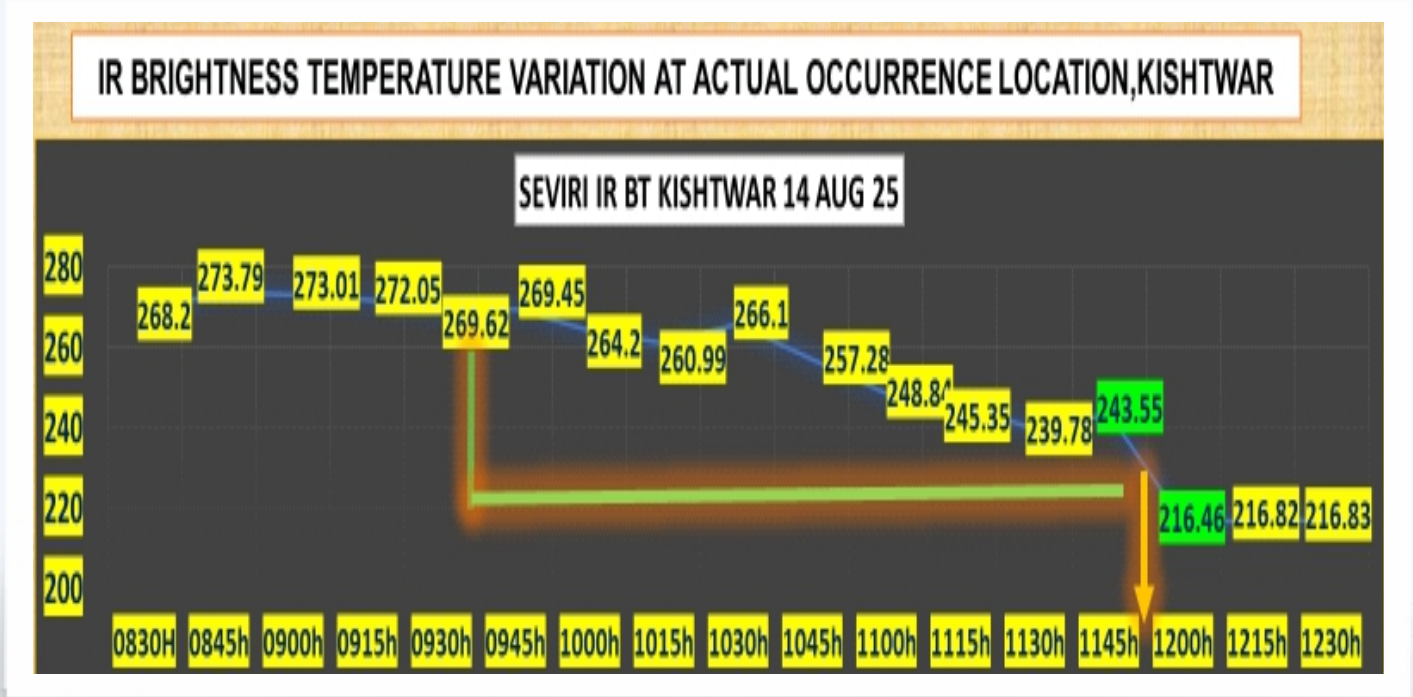
Sqn Ldr. R Arun
Meteorologist

Guide : **Dr Neerja Sharma**
Sci/Eng.-SF
EPSA-AOSG-ASD

Abstract

Study the impact of Integrating Cloud microphysical parameters in NETRA Operational Algorithm

The nowcasting of extreme weather events triggered by orography such as cloudbursts over the Indian region remains a significant operational challenge in aviation meteorology and disaster management. The Indian Space Research Organisation has developed the Nowcasting of Extreme Orographic Rain (NETRA) operational algorithm to identify potential cloudburst conditions using satellite-derived parameters. This relies heavily on cloud top cooling rate computed using INSAT TIR brightness temperature. However, cloud burst also involves the changes in cloud microphysical properties. Thus, present study investigates the impact of integrating cloud microphysical parameters in NETRA derived cloud burst alerts. For this purpose, study utilises INSAT-3DS and MSG-SEVIRI IODC derived brightness temperature and cloud parameters. The expected outcome is an advanced NETRA derived cloud burst nowcasting framework that leverages space based cloud microphysical parameters. This work has direct implications for aviation safety and operational forecasting, contributing to the advancement of satellite-based severe weather monitoring systems in India.



TIR1 CHANNEL BRIGHTNESS TEMPEARTURE(SEVIRI) VARIATION OVER KISHTWAR DURING CLOUD BURST OCCURRENCE ON 14 AUG 2025 AT 1130H.

Cdr DSV Sagar Varma
India

In the coastal city of Visakhapatnam, where the sight of naval ships is part of everyday life, Sagar Varma grew up watching the Indian Navy in action. The rhythm of the sea and the presence of uniformed officers left a lasting impression on him, quietly shaping a dream that would later define his life. Having completed his schooling, college and engineering in Visakhapatnam, he graduated in 2010 and soon set his sights on joining the Navy. Clearing the rigorous Services Selection Board (SSB), he was commissioned as a Naval Officer in 2011, marking the beginning of a journey built on discipline, resilience and continuous growth. Over the years, Commander Sagar has taken on a variety of roles across training establishments and command appointments, each adding depth to his professional experience. His aptitude for learning and teaching earned him the distinction of being selected as one of the key instructors for the Indian Navy's first Long Meteorology (Met) course, where he played a key role in mentoring and shaping future officers. A defining chapter in his career came with his selection as part of the commissioning crew of INS Vikrant. Being among the few entrusted with this responsibility stands as a testament to his competence and the confidence the Navy places in him. Beyond his duties in uniform, Commander Sagar is a man of varied passions. A keen photographer, he finds meaning in capturing moments through his lens. On the sports field, he has consistently excelled, representing teams in basketball and volleyball, embodying teamwork and competitive spirit. From a young boy inspired by the sea to a seasoned naval officer contributing to the nation's maritime strength, Commander Sagar Varma's journey is one of purpose, dedication and quiet achievement.

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Cdr DSV Sagar Varma
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Guide: **: Dr. Prashant Kumar**
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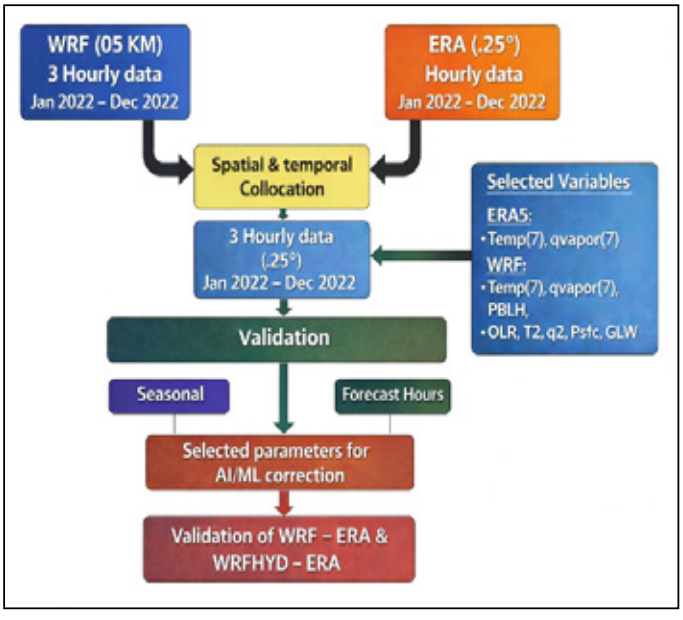
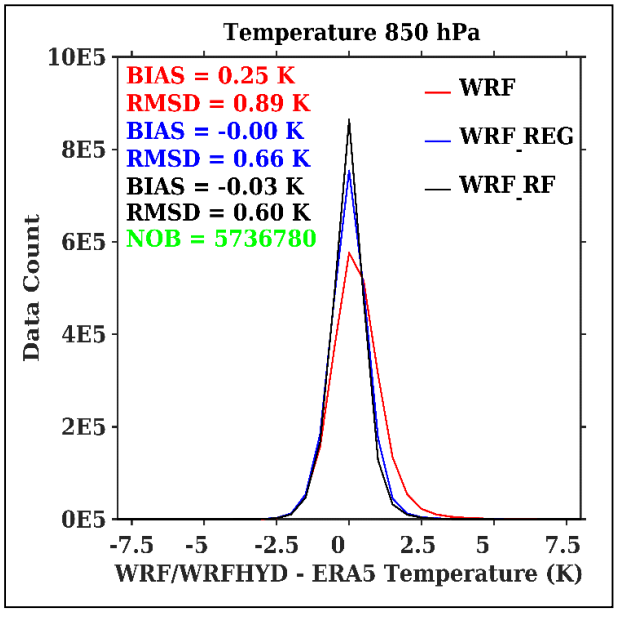
Abstract

Development of Hybrid Dynamical and Machine Learning Based Weather Forecasting Model for Naval Operations

The accuracy of short-range weather forecasts produced by high-resolution numerical weather prediction (NWP) models is often limited by surface heterogeneity, model uncertainties and limitations of data assimilation techniques. After a detailed verification of the Weather Research and Forecasting (WRF) model predictions against ERA5 reanalysis, this study demonstrates an application of hybrid weather forecasting, a combination of WRF model and machine learning (ML) methods, for thermodynamic indices. To achieve this objective, the WRF model generated temperature and moisture profile forecasts are corrected using selected (regression and random forest) ML algorithms to reduce inherent model errors. The performance of the default and hybrid weather models is evaluated for the year 2022 across three seasons: pre-monsoon (March–May), monsoon (June–September), and post-monsoon (October–December). In general, the performance of the WRF model is good enough for temperature prediction at 500 hPa and moisture prediction at 700 hPa and 500 hPa. Moreover, consistent improvements are observed in hybrid weather model prediction of temperature and moisture at lower levels (850 hPa). Furthermore, hybrid model simulated temperature and moisture profiles are utilised for crucial thermodynamic indices (extensively used as one of the forecast tools in the Indian Navy), which demonstrate significant improvement in forecast skill compared to default WRF forecasts. Overall, the results highlight the potential of integrating ML with NWP models to improve the accuracy and reliability of short-range weather forecasts.





Mr. Abdulla Naeem
Maldives

Born on 29th October 1979, on Hondaidhoo Island in H.Dh Atoll of the Maldives, Abdulla Naeem spent early childhood immersed in the unique environment and close-knit community of this small island. Due to challenging living conditions and as part of a government resettlement initiative, his family relocated to Hanimaadhoo Island in 2000. Today, Hondaidhoo remains uninhabited, but it holds a special place in his memories as their birthplace. In 2004, he embarked on a professional journey by joining the Hanimaadhoo Meteorological Center. Through years of dedicated service, Abdulla has continuously strived to grow and contribute to the field of meteorology. This commitment and passion for the profession have enabled him to serve the community by providing essential weather information and services—an invaluable role in the island nation.

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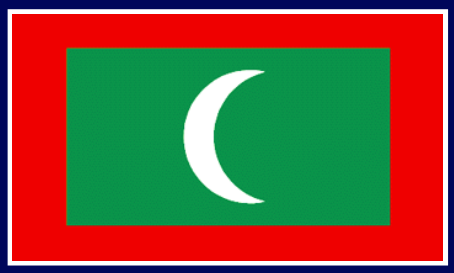
Physically fit and energetic, Abdulla thrives on adventure and outdoor activities. A deep love for the sea drives him to spend leisure time fishing, swimming, and deep free diving. These pursuits not only promote health but also strengthen [Name]'s connection to the natural beauty of the Maldives.
Beyond professional and personal interests, he is actively engaged in family and community life. Frequently assuming leadership roles in family matters and contributing to social causes,

Overall, Abdulla's life story is defined by resilience, adaptability, and a strong sense of community. He takes pride in the journey so far and looks forward to continuing to make a meaningful impact both professionally and personally.



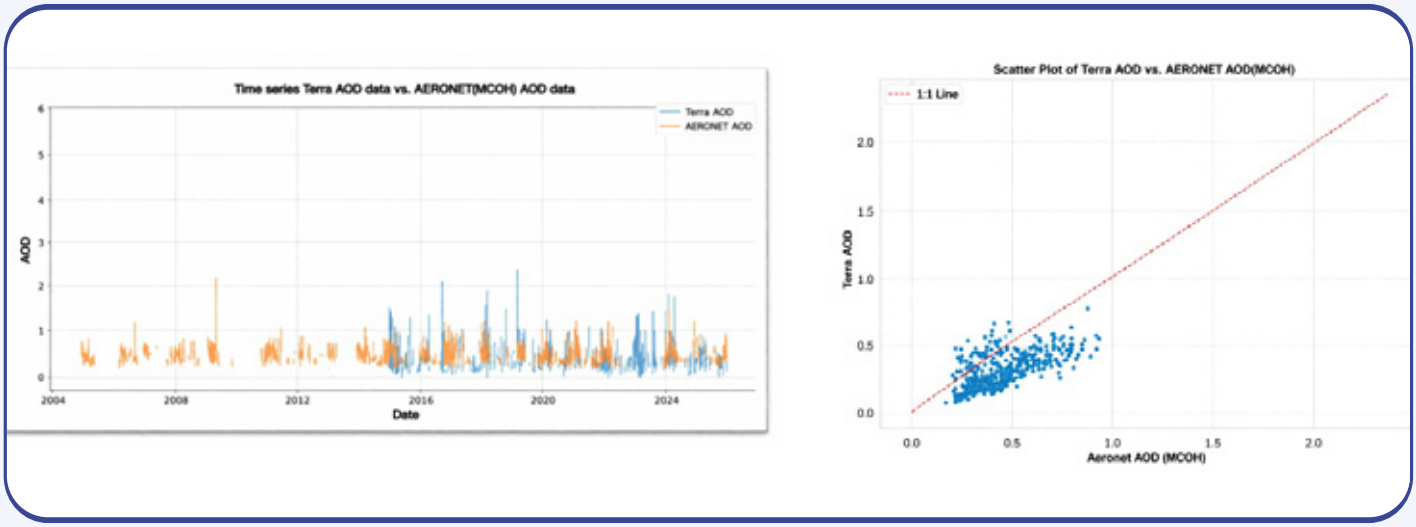
Mr. Abdulla Naeem
Meteorological Technician

Guide: **: Dr. Manoj Kumar Mishra**
Sci/Eng.-SF
EPSA-ATVG-ATDD

Abstract

Aerosols analysis over Maldives (2005-2025)

This study assesses Aerosol Optical Depth (AOD) trends over the Maldives from 2005 to 2025, combining ground-based AERONET data from Hanimaadhoo and Gan Islands with satellite-derived MODIS Terra and Aqua observations (2015–2025). A persistent year-on-year increase in AOD is observed, particularly during dry and pre-monsoon seasons. The rise is mainly driven by dust and pollutant transport from South Asia, local emissions from tourism, marine transport, open waste burning, and episodic biomass burning. MODIS and AERONET AOD data show strong agreement overall, despite some discrepancies. These findings highlight the need for enhanced aerosol monitoring and targeted policy interventions to address increasing aerosol-related risks in the Maldives.



Terra Vs AERONET Statistical Comparison Metrics

- Mean Difference (Terra AOD - AERONET AOD): -0.1007
- Root Mean Square Error (RMSE): 0.3077
- R (correlation coefficient): 0.55

Ms. Tugsjargal Oldogch
Mongolia

Born on a crisp November day in 1993 in the beautiful Khuvsgul province, Tugsjargal has always possessed a mind for patterns—whether on a chessboard or in the shifting clouds above. After earning her Bachelor's degree in Meteorology and Numerical Forecasting from the University of Mongolia in 2017, she stepped directly into the high-stakes world of the Aviation Meteorological Center. Never one to stop growing, she returned to her alma mater to complete her Master's degree in 2024. To further sharpen her technical and meterological skills she was selected for the SATMET 14 course. To know Tugsjargal is to know someone who values balance. Off the clock, you'll likely find her engaged in "intellectual sports," testing her strategy over a game of chess, finding her flow in yoga, or showing her competitive spirit at the table tennis table. She carries this same sense of self-reliance and quiet confidence into her professional life. Known by her peers for her honesty and ambitious spirit, she approaches every challenge with a refreshingly positive outlook. Tugsjargal's current mission is as vast as the Mongolian landscape. Her research focuses on the intricate world of cloud formation, a critical study for a nation defined by extreme continental climates—from the high mountain ranges and sweeping steppes to the silent stretches of the desert. In a land where geographical diversity causes clouds to develop and shift with startling speed, her work is essential for navigating the complexities of the Mongolian sky.

With her dedication to her craft and her love for the "long game," Tugsjargal is not just studying the weather; she is mastering the science of predicting the unpredictable.

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Ms. Tugsjargal Oldogch
Observation Engineer of Aviation Meteorological

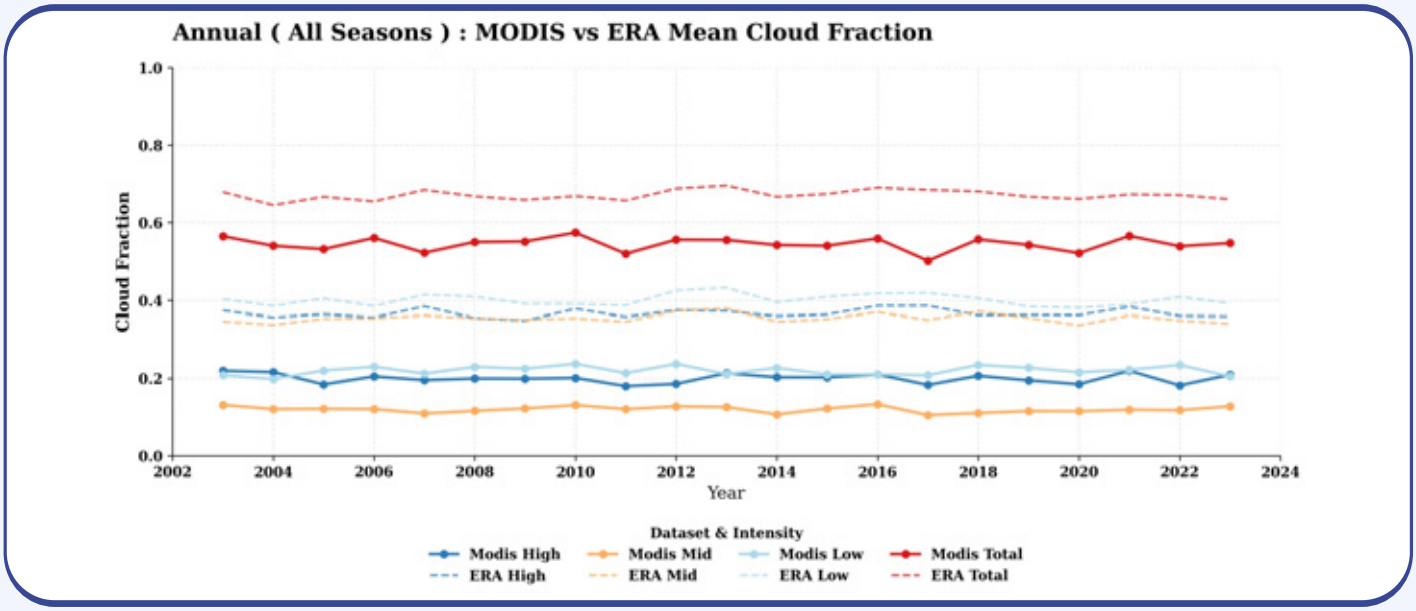
Guide: **: Mr. Prateek Kumar**
Sci/Eng.-SE, EPSA-AOSG-ASD

Abstract

Cloud Characteristics Over Mongolia MODIS vs ERA5 | 2003–2024

This study investigates the seasonal and spatial distribution of cloudiness over Mongolia using MODIS satellite observations, with a focus on the development of convective clouds and their relationship to severe weather events. The primary objective is to understand how cloud fraction varies across different seasons and how these patterns are linked to atmospheric processes and climate variability. The analysis is based on MODIS-derived cloud fraction data, complemented by atmospheric parameters such as instability indicators from ERA5 reanalysis. Seasonal patterns are examined for summer (JJA), winter (DJF), and transitional periods (MAM and SON). Results show that during summer, higher cloud fraction values are concentrated over central and northern Mongolia due to strong surface heating and enhanced atmospheric instability. These conditions promote the formation of deep convective clouds, particularly cumulonimbus (CB), characterized by strong vertical development and mixed-phase microphysical structure. Such clouds are closely associated with severe weather events including thunderstorms, heavy rainfall, and hail. In contrast, winter exhibits maximum cloud cover over northern and northeastern Mongolia, primarily influenced by large-scale climatic conditions and stable cold air masses associated with the Central Asian anticyclone. Transitional seasons display moderate and variable cloudiness, reflecting shifts between convective and stable atmospheric regimes. The findings highlight that convective cloud activity is most significant during summer, while winter cloud distribution is governed by synoptic-scale processes. Furthermore, the increasing frequency of severe weather events suggests a potential link to climate change, emphasizing the importance of integrating satellite observations with reanalysis data for improved weather forecasting and early warning systems. Overall, this study provides a comprehensive understanding of cloud dynamics over Mongolia and demonstrates the value of combining MODIS and ERA5 datasets for analyzing cloud properties and their climatic implications.

Key words: Cloud fraction, Mongolia, MODIS, Cumulonimbus clouds, Convective activity, Severe weather, ERA5



Ms. Urantsetseg Batmunkh
Mongolia

Born on a summer's day on 20 July 2000, Urantsetseg arrived with a purpose that would eventually lead her to the vast, blue horizons of her homeland. After graduating from the University of Mongolia in 2022 with a degree in meteorology, she didn't just study the skies—she decided to protect those living under them. Today, she serves as a dedicated Synoptic Engineer at the Hydrometeorology and Environment office in Khuvsgul province, where the weather is as much a part of life as the land itself. She works tirelessly to ensure that early warnings for extreme cold, floods, and heavy precipitation reach the public in time to make a difference. For her, meteorology isn't just about data points; it's about shielding her community from the unpredictable whims of nature.

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Urantsetseg's heart is currently set on the shores of Lake Khuvsgul. Her research during this course dives deep into the impacts of climate change on this vital region, driven by a deeply personal mission: safety. Her curiosity is as expansive as the Mongolian steppe. Urantsetseg remains fascinated by the shifting patterns of natural hazards and the accelerating pace of our changing climate. But she isn't walking this path alone; she is a true team player, committed to growing alongside her colleagues and lifting them up as she advances her own expertise.

With a quiet determination and a bright mind, she is fully dedicated to sharpening her skills, ensuring that her future—and the future of the communities she serves—is both resilient and well prepared.

Ms..Urantsetseg Batmunkh
Synoptic Engineer

Guide: **: Mr. Naveen Kumar Tripathi**
Sci/Eng.-SE
EPSA-CHSG-CSD

Abstract

CLIMATE CHANGE IMPACT IN LAKE KHOVSGOL REGION OF MONGOLIA

The Lake Khovsgol basin is located in the northern part of Mongolia, mainly within a high mountain zone, and in terms of physical geography, it belongs to the Khovsgol Mountains, which are part of the Khangai–Khentii mountainous region.

The highest point in this area is the peak of the Munkh Saridag Range, rising to 3,491 meters above sea level, while the lowest point is the surface of Lake Khovsgol, at an elevation of 1,647.8 meters above sea level. Lake Khovsgol extends 136 km from north to south, with an average width of 20.3 km and a maximum width of 37.0 km. Its water transparency reaches 24 meters, the average depth is 138 meters, and the maximum depth is 262.4 meters. The lake has a surface area of 2,760 km², a catchment area of 49,025 km², and contains approximately 380.7 km³ of water.

This study aims to investigate the characteristics and changes of the climate in the Lake Khovsgol region, located in the northern part of Mongolia. To examine climate change and its impacts, observational data on air temperature and precipitation from the Khatgal meteorological station, located on the southern shore of Lake Khovsgol, covering the most recent 40-year period from 1985 to 2025, were used. In addition, data on lake water level and ice thickness from the hydrological station were also utilized. Furthermore, ERA5 reanalysis air temperature data were compared with in-situ observational data to evaluate their relationships, consistency, and temporal trends using quantitative and statistical methods.

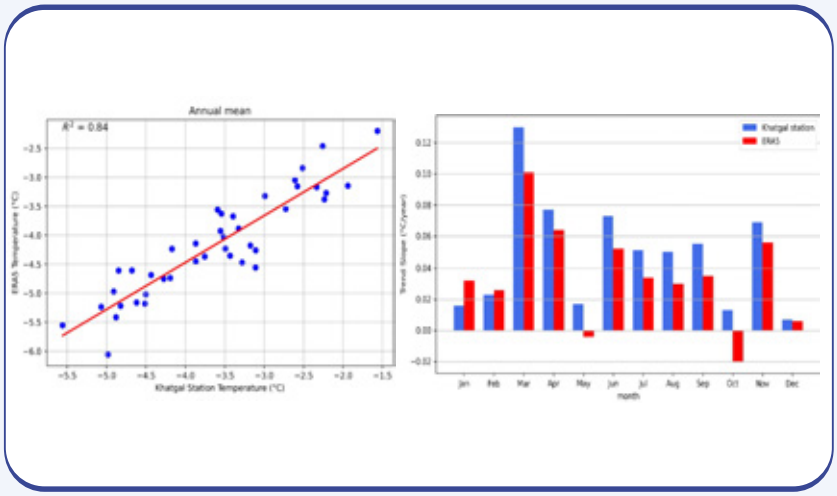

Figure 1: The comparison of annual mean and month-wise slope of the trend of air temperature over Khovsgol lake: Station and ERA-5 data

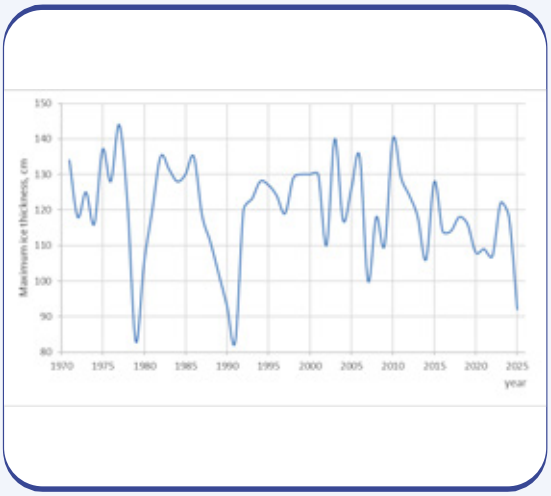

Figure 2: The maximum lake ice thickness variations of Khovsgol lake

Mr. Bomil Alesana
Papua New Guinea

For Bomil, a dedicated professional with the Papua New Guinea National Weather Service (PNGNWS), understanding those skies has become a global odyssey that has taken him from the shores of his homeland to the high-tech laboratories of India. Born and raised in Papua New Guinea, Bomil's path to the upper atmosphere began on solid ground. After completing college in 2014 and spending four years honing his skills in the private sector, he felt a calling toward public service. In 2019, he stepped into the world of meteorology, joining the PNGNWS cadet program. Though the global pandemic paused the woshortly after he began, Bomil's resolve never wavered. He officially launched his professional career in 2022, eager to bridge the gap between atmospheric theory and the practical needs of his country.His pursuit of excellence has led him across borders, starting with a 2024 professional certification at PAGASA in the Philippines. However, his most ambitious academic venture began in August 2025. Nominated by PNGNWS management, Bomil traveled to Ahmedabad, India, to join the Fourteenth Postgraduate Course in Satellite Meteorology and Global Climate. Hosted by CSSTEAP at the prestigious Indian Space Research Organisation (ISRO), this nine-month intensive program immersed him in the cutting edge of space science. He believes that interacting with people from different backgrounds is just as vital as the data he analyzes. For Bomil, this isn't just about personal growth; it's about institutional transformation. He sees a future where the PNGNWS is empowered by the same sophisticated technological capabilities he witnessed abroad. As he prepares to return home in May 2026, Bomil carries more than just a certificate. He carries a vision. He hopes to translate his international experiences into tangible support for his management and colleagues. By applying his newfound skills in satellite technology, he aims to contribute to a safer, more climate-resilient Papua New Guinea.

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Mr. Bomil Alesana
Weather Forecaster (Meteorologist)

Guide: **: Dr. Rishi Kumar Gangwar**
Sci/Eng.-SF
EPSA-AOSG-ASD

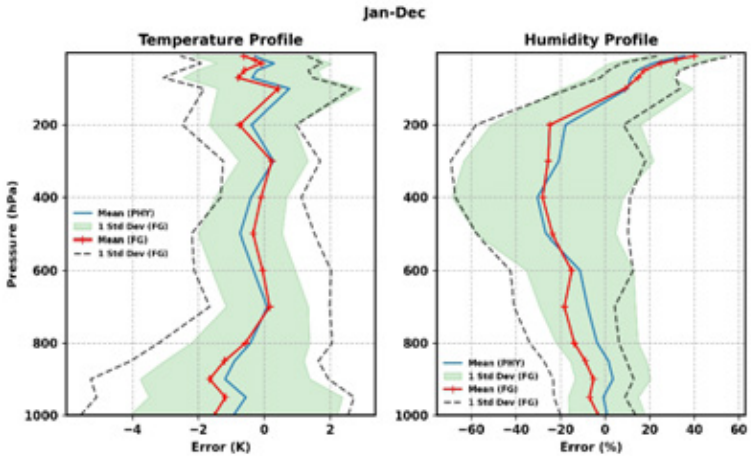
Abstract

Quantitative Assessment of Atmospheric Temperature and Humidity Profiles from IASI and ERA5 over Papua New Guinea

Atmospheric temperature (T) and humidity (Q) profiles are fundamental parameters for understanding weather systems, climate variability, and atmospheric processes. However, in regions such as Papua New Guinea (PNG), the availability of in-situ observations (e.g., radiosonde measurements) is extremely limited due to geographical, logistical, and infrastructural constraints. This lack of ground-based data poses a significant challenge for validating atmospheric products and understanding regional atmospheric structure.

In this study, we perform a quantitative assessment of satellite-derived atmospheric profiles from the Infrared Atmospheric Sounding Interferometer (IASI) against reanalysis data from the European Centre for Medium-Range Weather Forecasts (ERA5) over the PNG region. Collocated profiles are extracted for selected dates throughout the year 2025, and vertical interpolation is applied to ensure comparison on a common pressure grid. Statistical metrics including Bias and Root Mean Square Deviation (RMSD) are computed to evaluate the agreement between IASI and ERA5 for both temperature and humidity.

This study highlights the importance of satellite observations as a critical alternative for atmospheric monitoring in regions lacking in-situ measurements. The findings demonstrate the potential of combined satellite–reanalysis approaches to improve atmospheric understanding over PNG and support future efforts in weather forecasting, climate studies, and observational network development.

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अहमदाबाद
SPACE APPLICATIONS CENTRE
इसरो
SAC


RAMOJI


केंद्र
SPACE APPLICATIONS CENTRE
हमारो इसरो


nrsc

Educational and Cultural Exposure

Reflections from participants of the CSSTEAP PG Diploma Course in Satellite Meteorology and Global Climate

Being selected from our respective organizations to participate in the CSSTEAP Post Graduate Diploma Course in Satellite Meteorology and Global Climate (SATMET-14) at the Space Applications Centre (SAC), Ahmedabad, was a moment of pride for each one of us. Coming from different professional backgrounds and even different countries, we arrived with curiosity, excitement, and a shared interest in understanding how satellite technology helps us observe and interpret the Earth's atmosphere. When we first gathered in August 2025, we were a group of professionals meeting for the first time. None of us could fully imagine how meaningful the coming months would become. What began as a professional training programme gradually evolved into a memorable journey of learning, discovery, and friendship.

For many of us, the course also brought back a sense of academic nostalgia. After years of professional responsibilities, returning to a classroom environment reminded us of our student days—attending lectures, discussing ideas with classmates, and exploring scientific concepts with renewed curiosity. This time, however, the learning carried an even deeper purpose: strengthening our professional skills and understanding how satellite observations support meteorological analysis and forecasting.

As one participant reflected:

“SATMET-14 reminded me how exciting learning can be. It felt like being a student again—but with real-world experience to connect the science with practice.”

A New Beginning in Ahmedabad

Our arrival in Ahmedabad marked the beginning of an exciting chapter. Adjusting to a new city and environment could have been challenging, but the welcoming atmosphere and thoughtful arrangements at SAC helped us settle in quickly. Soon, the campus began to feel like home. Informal conversations during meals, discussions in hostel corridors, and evening walks around the campus often turned into lively exchanges about satellite images, weather systems, and our professional experiences.

The inaugural programme brought us together as a class for the first time. Listening to the inspiring words of senior scientists and the course officer gave us a glimpse of the importance of satellite meteorology in modern weather science and set the tone for the months ahead.

Understanding the Atmosphere from Space

The academic component of SATMET-14 was both comprehensive and engaging. The curriculum introduced us to a wide range of topics—from the fundamentals of atmospheric science to advanced applications of satellite observations in weather forecasting and climate studies.

The lectures were delivered by experienced scientists who combined theoretical knowledge with insights from real research and operational work. Gradually, we developed a deeper appreciation of how satellites observe atmospheric processes and how this information is transformed into useful meteorological products.

Hands-on sessions were an equally important part of the course. Working with satellite imagery and meteorological datasets allowed us to translate theory into practice.

As one participant described:
“The practical sessions changed the way we look at satellite data. What once appeared as simple images now reveal detailed stories about the atmosphere.”

Learning Through Research
The project phase gave us the opportunity to apply what we had learnt during the coursework. Under the guidance of expert scientists, we worked on research topics related to satellite observations and atmospheric processes. Exploring real datasets and interpreting meteorological phenomena using satellite information was both challenging and rewarding.

Learning Beyond the Classroom
Some of the most memorable moments of the course came from the study visits organised during the programme. Visits to institutions such as NRSC Hyderabad, SHAR Sriharikota, and IIRS Dehradun allowed us to see firsthand how satellite technology is developed, launched, and applied in various fields.

The study tours also offered an opportunity to experience India's cultural diversity. Travelling to different cities, exploring historic landmarks, and enjoying regional cuisines added a delightful dimension to our journey. Among the highlights was our visit to the iconic Taj Mahal, a moment that many of us will always remember.

Friendship Across Borders
Perhaps the most meaningful outcome of SATMET-14 was the friendships that developed during these nine months. With participants representing different countries and professional backgrounds, the course became a unique platform for both scientific exchange and cultural interaction.

Working together on projects, travelling during study tours, and sharing everyday experiences helped us form strong bonds. Our discussions often went beyond meteorology—into conversations about culture, traditions, and life experiences from our respective countries.

As one participant beautifully expressed:

“We arrived here as professionals from different parts of the world, but we leave as friends who shared an unforgettable journey.”

Impressions of the Participants

Looking Back with Gratitude

As the course draws to a close, we reflect on the past nine months with gratitude and pride. SATMET-14 has broadened our understanding of satellite meteorology, strengthened our professional capabilities, and introduced us to new perspectives in weather and climate science. Beyond the academic achievements, however, it is the memories and friendships that we will cherish the most.

As we prepare to return to our respective organizations, we express our heartfelt gratitude to the scientists, faculty members, and administrative staff of SAC, ISRO, the Bopal campus, and CSSTEAP Headquarters in Dehradun for their constant guidance and support throughout this journey.

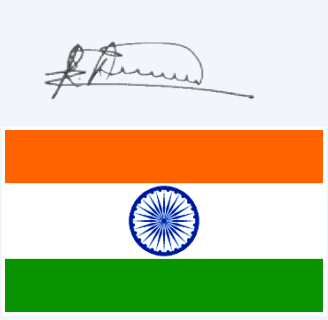
SATMET-14 has been far more than a training programme for us. It has been a journey of learning, discovery, and friendship—one that will remain a cherished chapter in our lives.

Mr. Md. Hasanul Banna
Bangladesh

Md. Zoynal Abedin
Bangladesh

Mr. Tesfay Ljalem Weldeslassie
Ethiopia

Cdr Anish Kumar
India



Sqn Ldr R Arun
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Cdr DSV Sagar Varma
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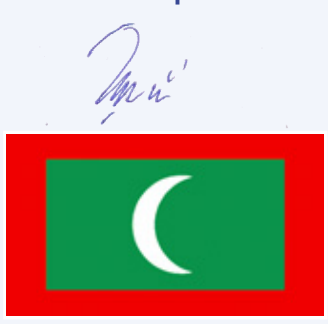

Mr. Abdulla Naeem
Maldives

Ms. Tugsjargal Oldogch
Mongolia

Ms. Urantsetseg Batmunkh
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Mr. Bomil Alesana
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CENTRE FOR SPACE SCIENCE AND TECHNOLOGY EDUCATION IN ASIA AND THE PACIFIC (CSSTE-AP)

14th POST GRADUATE COURSE IN SATELLITE METEOROLOGY AND GLOBAL CLIMATE

[SATMET – 14]

(August 01, 2025 to April 30, 2026)

Sitting: (L to R) Dr. D. Pallamraju, Prof. J Banerji, Shri. Anil Bhardwaj, Shri. Nilesh M Desai, Dr.Sasmita Chaurasia

Standing: (L to R) Mr. Abdulla Naeem (Maldives), Ms. Urantsetseg Batmunkh (Mongolia), Ms. Tugsjargal Oldogch (Mongolia), Mr. Bomil Jackson Alesana (Papua New Guinea), Mr. Md. Hasanul Banna (Bangladesh), Cdr. DSV Sagar Varma (India), Cdr. Anish Kumar (India), Mr. Md. Zoynal Abedin (Bangladesh), Sqn Ldr. R. Arun (India), Mr. Tesfay Ljalem Weldeslassie (Ethiopia)

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