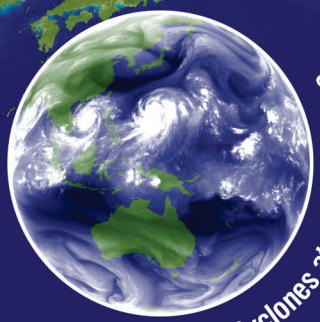
NINTH POST GRADUATE COURSE IN

SATELLITE METEOROLOGY AND GLOBAL CLIMATE

August 1, 2014 to April 30, 2015

Memoirs



3 Tropical Cyclones at one time - 2013

Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP)
(Affiliated to the UN)
www.cssteap.org

Organised By
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Indian Space Research Organisation (ISRO)
Ahmedabad.
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NINTH POST GRADUATE COURSE IN

SATELLITE METEOROLOGY AND GLOBAL CLIMATE

AUGUST 1, 2014 TO APRIL 30, 2015

AT

SPACE APPLICATIONS CENTRE

AHMEDABAD

Memoirs

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Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP)
(Affiliated to the UN)

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आ. सी. किरण कुमार / A. S. Kiran Kumar
अध्यक्ष / Chairman

MESSAGE

I am pleased to note that the 9th Post Graduate Course on "Satellite Meteorology and Global Climate" organized by the Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP) and conducted by Space Applications Centre (SAC), Ahmedabad is closing successfully on April 30, 2015. I am also happy to understand that 17 participants from eight countries of the Asia Pacific region will be receiving their diploma certificates.

The advent of satellite-based observations, over the past few decades, has added new dimension to the study of atmosphere and weather systems. The scientific advances in satellite technology in terms of high resolution, multi-spectral bands covering visible, infrared and microwave regions with enhanced radiometry and temporal resolution have made space data an indispensable component in weather monitoring and dynamic modeling. INSAT based Satellite data have been effectively used in studying and simulating weather conditions in terms of diurnal variations, short-range forecasts, cyclone monitoring, etc., contributing to disaster risk reduction.

I am sure that well-structured course curriculum, teaching by the expert faculties, state-of-the-art facilities for satellite data processing and their hands-on-experience in project work, significantly enhanced the working knowledge of the participants and it will be useful in their future assignments.

I congratulate all the participants and wish them all the success in their future endeavours. I extend my compliments to the faculties for their sincere efforts in conducting the successful training programme.

आ सी किरण कुमार

(आ. सी. किरण कुमार)
(A. S. Kiran Kumar)

Bangalore
April 17, 2015

Messages

UNITED NATIONS
Office for Outer Space Affairs

Simonetta Di Pippo
Director
Office for Outer Space Affairs

I wish to congratulate students of the 9th Post Graduate Course on "Satellite Meteorology and Global Climate" for their successful completion of the Post-Graduate Diploma Programme at the Centre for Space Science and Technology Education in Education in Asia and the Pacific, affiliated to the United Nations, (CSSTEAP) on 30 April 2015. This course, held at the Space Applications Centre in Ahmedabad, is rigorous and demanding, but we have seen the positive impacts the course has made in helping prepare young professionals embark on fruitful careers.

In the post-2015 global development context, I am personally convinced that studies of satellite and meteorology are important for generating the human capital required by nations to improve their approach to disaster risk management and their preparedness for the impacts of climate change, for example in providing knowledge for early warning of meteorological disasters. I am sure the course has achieved this objective by imparting advance knowledge of the subject, as well as skills in using models and analytical tools with a wide range of operational satellite data.

As one of the Regional Centres for space science and technology education, affiliated to the United Nations, CSSTEAP is conducting post graduate diploma programmes and short-term courses on Satellite Meteorology and Global Climate in an exemplary fashion and continues to be a model in building the capabilities nations require to protect their population and develop their economy.

I would like to end my message by urging the countries in Asia and Pacific to partake in the benefits provided by the Regional Centres and in committing resources to ensure its continuity.

Simonetta Di Pippo
Director
Office for Outer Space Affairs

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16 April 2015

MESSAGE

I am happy to know that the CSSTEAP is bringing out Memoirs on the occasion of successful conclusion of the Ninth Post-Graduate Course on "Satellite Meteorology and Global Climate" conducted from 1st August 2014 to 30th April 2015 at the Space Applications Centre, Ahmedabad, India.

Climate change has become a critical global concern. Our region is prone to various climatic vulnerabilities. We need to focus on building community resilience through capacity development and disaster risk reduction activities. Study of meteorology and climate change science is important to understand the severity of climate change impacts and develop disaster preparedness capacity. Satellite images and data analysis provide timely insights into extreme weather conditions thereby preparing professionals for better weather forecasting, analysing climate change impacts and devising innovative technologies and solutions. In this context, networking among professionals and researchers is equally helpful for improving meteorological disaster prevention and mitigation capabilities. In Nepal, we are giving priority to education and application of science and technology for sustainable development efforts.

It is a matter of great satisfaction that the Space Applications Centre has been conducting Post-graduate Course in "Satellite Meteorology and Global Climate" thus giving an opportunity of exchanging ideas and developing global vision for all participants of Asia and the Pacific region. Let me congratulate Course Director, Dr. B. Simon and his team as well as all the participants for successfully completing this important course.

Thank you very much.

Yours truly,

Tirtha Raj Wagle
Minister Counsellor

CSSTEAP Centres &
The Course - A Report

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

Dr. Y.V.N. Krishna Murthy

Director, CSSTEAP

IIRS Campus, 4 Kalidas Road, Dehradun- 248001

Introduction

Space science and technology have contributed significantly to the socio-economic development of many developed and developing countries. Knowledge about time and space has economic and social benefits that contribute in meeting several societal needs, from human security to sustainable development. Continuous development of human resources is crucial to ensure the scientific & technological as well as economic, social and cultural development in any country. Strategies for developing human resources should be based on broad and long-term perspectives of the regional needs and resources through awareness, training and education. In order to develop these capabilities, nations or regions should be able to share their expertise and should also evolve opportunities to encourage awareness and train the manpower. In recognition of such a pre-requisite, a consensus has emerged within the international community that if effective assimilation and appropriate application of Space Science & Technology are to succeed in developing countries, devoted efforts must be made for the development of the necessary human and infrastructural capacity in all fields. A comprehensive training and education in Remote Sensing & Geographic Information System (RS & GIS) would enable developing countries to build a capability in the field, and to educate and stimulate students in other disciplines as well.

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 imparting education/training in the areas of RS&GIS, Satellite Communications, Satellite Meteorology and Global Climate, Space and Atmospheric Science, Navigation and Satellite Positioning System and Small Satellite Missions using modern infrastructure, technology and training tools and practices. The Centre has also announced a new Post Graduate course on Global Navigation Satellite Systems (GNSS) from 2015 and is hosted by Space Applications Centre, ISRO Ahmedabad.

The Centre's headquarter is located in Dehradun, India, and its programmes are executed by faculty of the Department of Space (DOS) at campuses in Dehradun, Ahmedabad 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 ISRO Satellite Centre (ISAC), Bengaluru for short course on Small Satellite Missions. 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, NRSC and ISAC. The Centre has an Governing Board consisting of signatories from 16 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.

Mr. A.S. Kiran Kumar,
Chairman,
ISRO/ Secretary Department of Space and present Chairman Governing Board during the 19th GB meeting at Bangalore

Governing Board members during 19th GB meeting chaired by Dr. K. Radhakrishnan, Chairman, CSSTEAP GB

The course curricula developed by the Centre and endorsed by the United Nations are adapted for the educational programmes. The educational programmes 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 a 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 programmes on specific themes in the four areas, highlighting how space-based information can be used for national development. These educational programmes have benefited many scientists/engineers who will be the future policy & decision makers in several countries.

CSSTEAP conducts all of its educational programmes 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 students and the management of the centre are mainly provided by Department of Space on behalf of Host country. UN-OOSA also provides funding for travel of the participants. Other agencies financially contribute include are UN Agencies like UNSPIDER, Beijing, China; UN-ESCAP in Bangkok, Thailand, UNESCO and UNDP.

Educational Programmes

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

(a) Remote Sensing and Geographic Information Systems (RS & GIS),

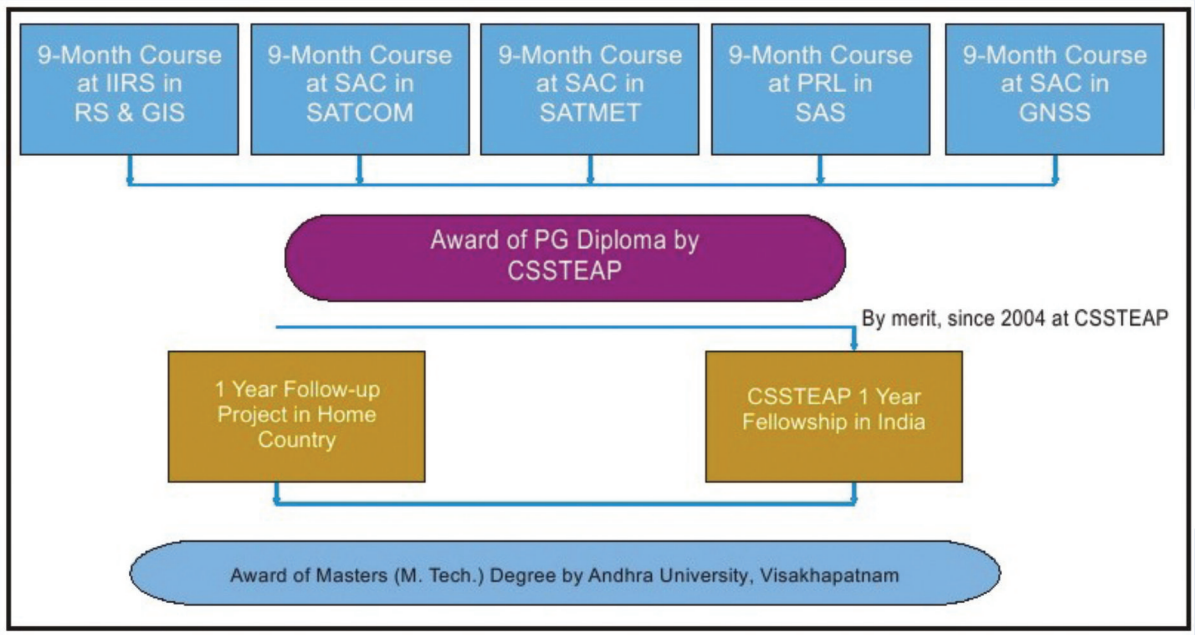
(b) Satellite Communication (SATCOM),

(c) Satellite Meteorology and Global Climate (SATMET)

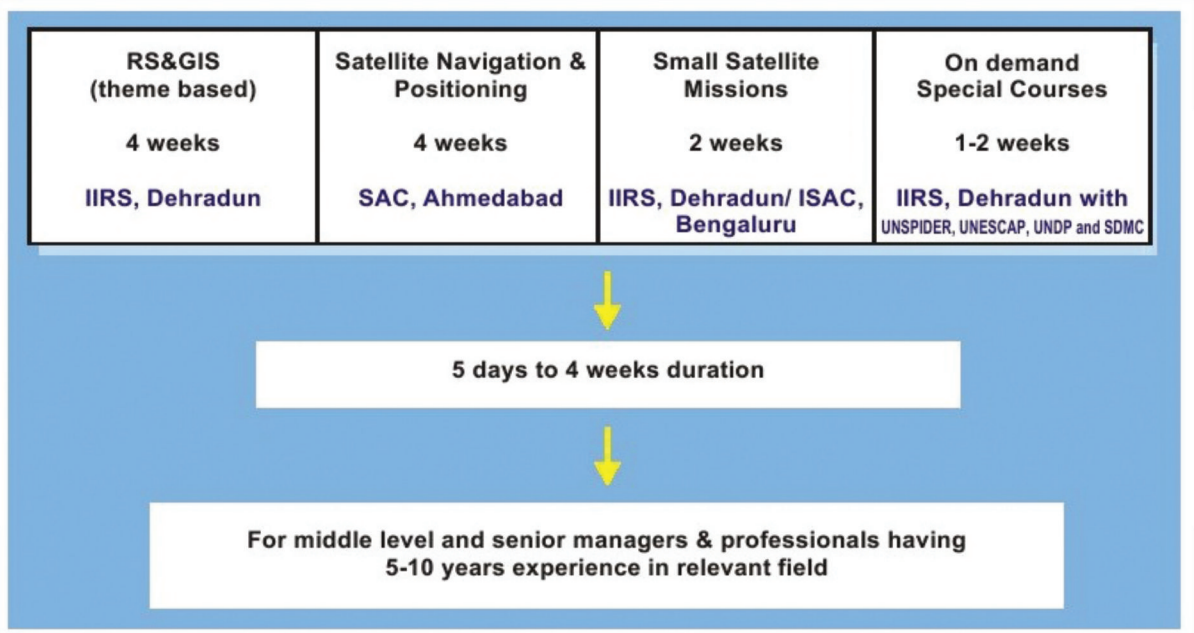
(d) Space and Atmospheric Science (SAS), and

(e) Global Navigation Satellite Systems.

Apart from these, Centre conducts short courses on different themes of Remote Sensing and GIS, Small Satellite Missions and Navigation and Satellite Positioning system on regular basis. The Centre also organizes workshops & awareness programmes from time to time



Structure of PG diploma educational programmes



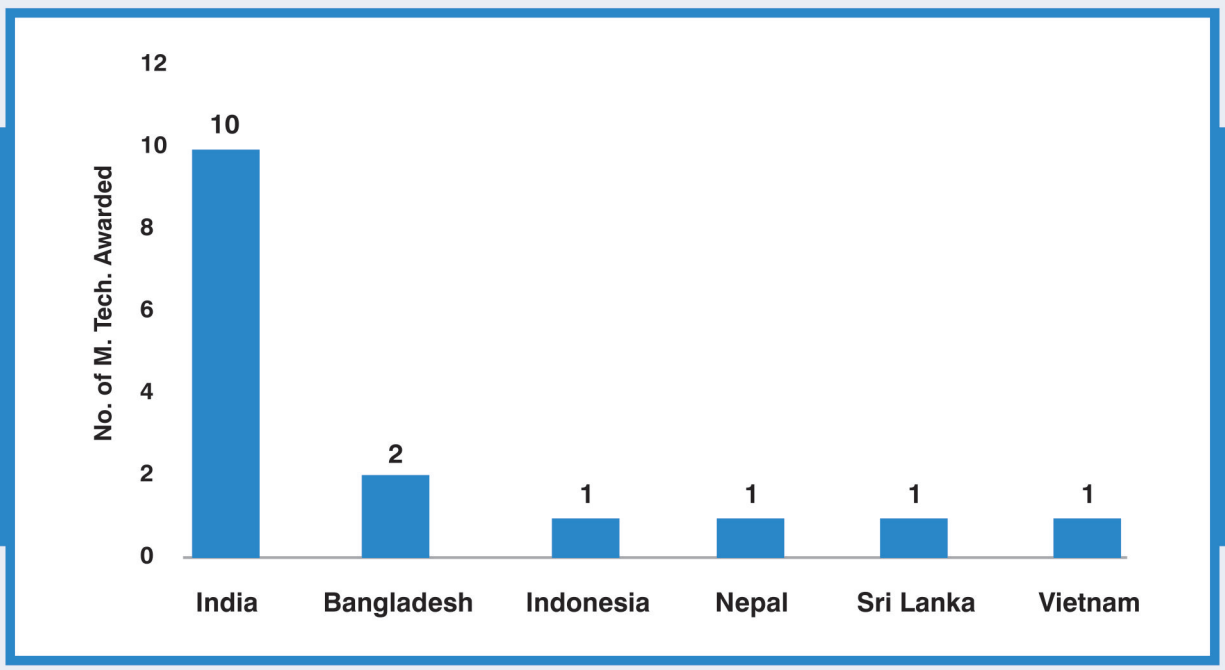
Structure of PG diploma educational programmes

The educational programmes are conducted in English and for students 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 institution (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 students 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. For the students who successfully finish their PG course and are interested in continuing for a Master of Technology (M.Tech.) degree, the Centre offers the opportunity to do so, in collaboration with Andhra University (AU) in Visakhapatnam, India. To this end, the student has to complete a 1-year research project in an application of space science or technology. This project has to be approved by CSSTEAP and AU, and the research is supervised by designated academic staff of CSSTEAP, AU and the institution where the research is carried out. In most cases the 1-year project is carried out at the home institution of the student concerned. Since 2004 onwards every year selected meritorious PG students in RS & GIS are being given fellowships to complete their M.Tech. thesis work at CSSTEAP. In year 2004 four PG students (one each from Azerbaijan, Bangladesh, Kyrgyzstan and Nepal), in year 2005 one student from Nepal, in 2007 one student from Mongolia, in 2008 one student from Indonesia, in 2009 one student from Myanmar were given M.Tech. fellowships to complete their M.Tech. research work at CSSTEAP and all have completed and degree has been awarded M.Tech. degree. In 2011 one student from Sri Lanka, in 2012 three PG students (one from each India, Nepal and Vietnam) have been awarded fellowship, in 2013 four students (one each from Bangladesh, Nepal and two from India) and in 2014 two students (India & Nepal) have been awarded fellowship. In the year, 2014, two participants of 8th SAS PG course each from Mongolia and Kyrgyzstan have been awarded M.Tech. fellowships.

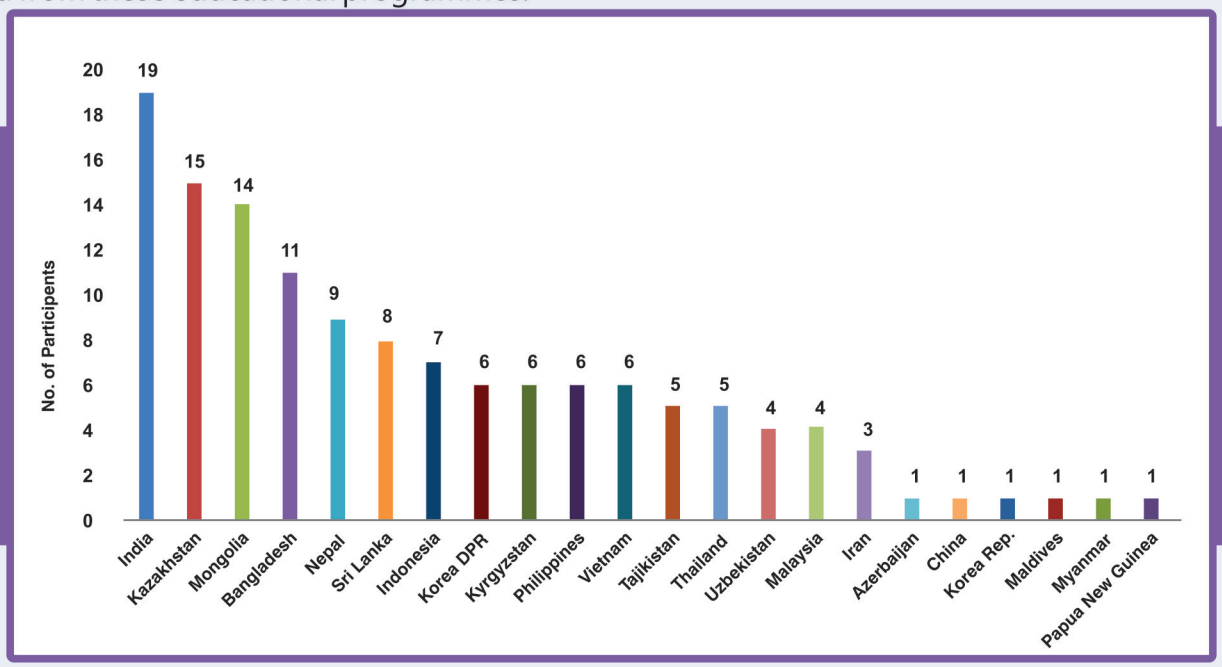
Till date 123 PG students (61 in RS & GIS; 32 in SATCOM; 16 in SATMET and 14 in SAS) from 16 different countries have been awarded M.Tech. degree. The country-wise distribution of M.Tech. degree awarded in SAS course is shown below:



Status of M.Tech. degree awarded in SAS

Achievements

Till date the Centre has conducted 44 PG courses: 19 in RS & GIS, 9 in SATCOM and 8 each in SATMET and Space & Atmospheric Science. In addition, the Centre has conducted 38 short courses and workshops in the past 19 years. These programmes have benefited some 1410 participants from a total of 34 countries in the Asia-Pacific region and 29 participants from 18 countries outside Asia Pacific region have also benefited from these educational programmes.



Country wise passed out students in SATMET PG course

The centre has played a major role in the development of curricula of four courses which are currently being followed by all the CSSTEAP's. All course materials are published by the Centre in the form of hard-copy lecture volumes and CDs. The Centre further publishes conference proceedings and other outreach documents, such as general information brochures, course announcement brochures, newsletters and memoirs- marking the end of every PG course. A half yearly newsletter is published regularly and sent to all alumni and to persons and institutions associated with the Centre. CSSTEAP has scientific and research collaborations with University of Illinois, USA; TWAS-UNESCO; ICIMOD, Nepal for cooperation and mutual assistance in the areas of education and research.

In order to obtain first hand feedback, understand the alumni role in promoting space technology in their countries and to develop a network & establish meaningful linkages between CSSTEAP & its alumni, CSSTEAP has taken initiative to hold alumni meets in different countries of the region. In this direction, five alumni meets have been successfully conducted: in Kathmandu (Nepal); Dhaka (Bangladesh); Colombo (Sri Lanka); Thimpu (Bhutan) and Yangon (Myanmar).

Pilot research case studies in the form of student project work showing the potential application of space science and technology in natural resources management, improved meteorological, communications studies etc., in Asia-Pacific region is being done by the Centre. The centre initiated research activities in the form of Phase-II of PG course i.e., M.Tech. research work by eligible PG students. The centre has taken initiative to facilitate its alumni to do higher studies leading to Ph. D. degree and M. Sc. and centre provides support in terms of expert faculty to guide the student for analyses and logistics (accommodation, research lab, library access, etc.). This year one student from Nepal, for Ph. D. degree, one from Nepal and one from Bangladesh for M.Tech. degree have been supported.

To generate awareness among users, researchers, engineers, professionals, decision makers and academicians, in year 2014, the Centre organised 3 short courses on specialized areas of Remote Sensing & its applications: (a) Short Course on Microwave Remote Sensing & its applications during May 2014; (b) special course on GIS & RS in Disaster Risk & Emergency Management in South-Asia jointly with SAARC DMC New Delhi during July 2014; (c) Special course on Disaster Damage Assessment using Geo-spatial Technologies in collaboration with UN-ESCAP, Bangkok during December 2014. We gratefully acknowledge the funding and sponsorships provided by SDMC, UNESCAP and UNSPIDER.

The centre has established international linkages with various organizations viz., UN-OOSA, UN-SPIDER, UN-ESCAP, UNESCO, UNDP, COSTED, WMO, START-SASCOM, NAM S& T, TWAS towards few fellowships / travel support/ sponsor short courses. There are also linkages with other Universities / Institutes (Institute of Space and Astronautical Science (ISAS), Japan; University of Illinois; Frieburg University, Germany; SSNEOG, Australia; EUMETSAT, U.K ; Onera, France; University of Colorado, University of Reading, U.K; NOAA-USA, University of Wisconsin, USA; University college of London, U.K; University of Hannover, Germany, etc.) for Guest Faculty and scientific exchange programmes. In India, apart from DOS/ISRO Centers CSSTEAP has linkages with many universities and academic institutions for imparting education/training

Space Applications Centre
Ahmedabad

Space Applications Centre

Harnessing space technology for societal benefits

Shri Tapan Misra

Director, SAC

Space Applications Centre (SAC) as one of the major centres of the Indian Space Research Organisation (ISRO) focuses on the design of space-borne instruments for ISRO missions and development and operationalisation of applications of space technology for societal benefits. The applications cover communication, broadcasting, navigation, disaster monitoring, meteorology, oceanography, environment monitoring and natural resources survey. SAC designs and develops the transponders for the INSAT and GSAT series of communication satellites, payloads for navigation satellites and the Optical and Microwave sensors for IRS series of remote sensing satellites. Further, SAC develops the ground transmit/receive systems (earth stations/ground terminals) and data/image processing systems. In order to carry out the above tasks, SAC has highly sophisticated payload integration laboratories, electronic and mechanical fabrication facilities, environmental test facilities, systems reliability/assurance laboratories, image processing and analysis facilities, project management support group and a well-stocked library. A large number of backbone activities take place in the Managerial systems which make the environments conducive for the realization of Research, development & project activities in the Centre. These activities include projects planning and evaluation, budget planning and expenditure monitoring, manpower planning, international cooperation, technology transfer and industrial interface, human resources development, management information, information technology and networks, RESPOND & Research coordination and space exhibition (in-house and mobile). The Centre also conducts nine-month post graduate diploma courses for students from the Asia Pacific region under the aegis of the Centre for Space Science and Technology Education (CSSTEAP) in satellite meteorology and communication.

The Centre has its origin in the establishment of the Experimental Satellite Communication Earth Station (ESCES), in 1966 by late Dr Vikram Sarabhai in Ahmedabad. Different units carrying out early experiments in communication, remote sensing and meteorology were amalgamated to form the Space Applications Centre in 1972 with Prof Yash Pal, the eminent scientist as its first Director. Present strength of SAC is about 1780 comprising about 1450 scientific & technical and about 330 administrative personnel.

The Organisation

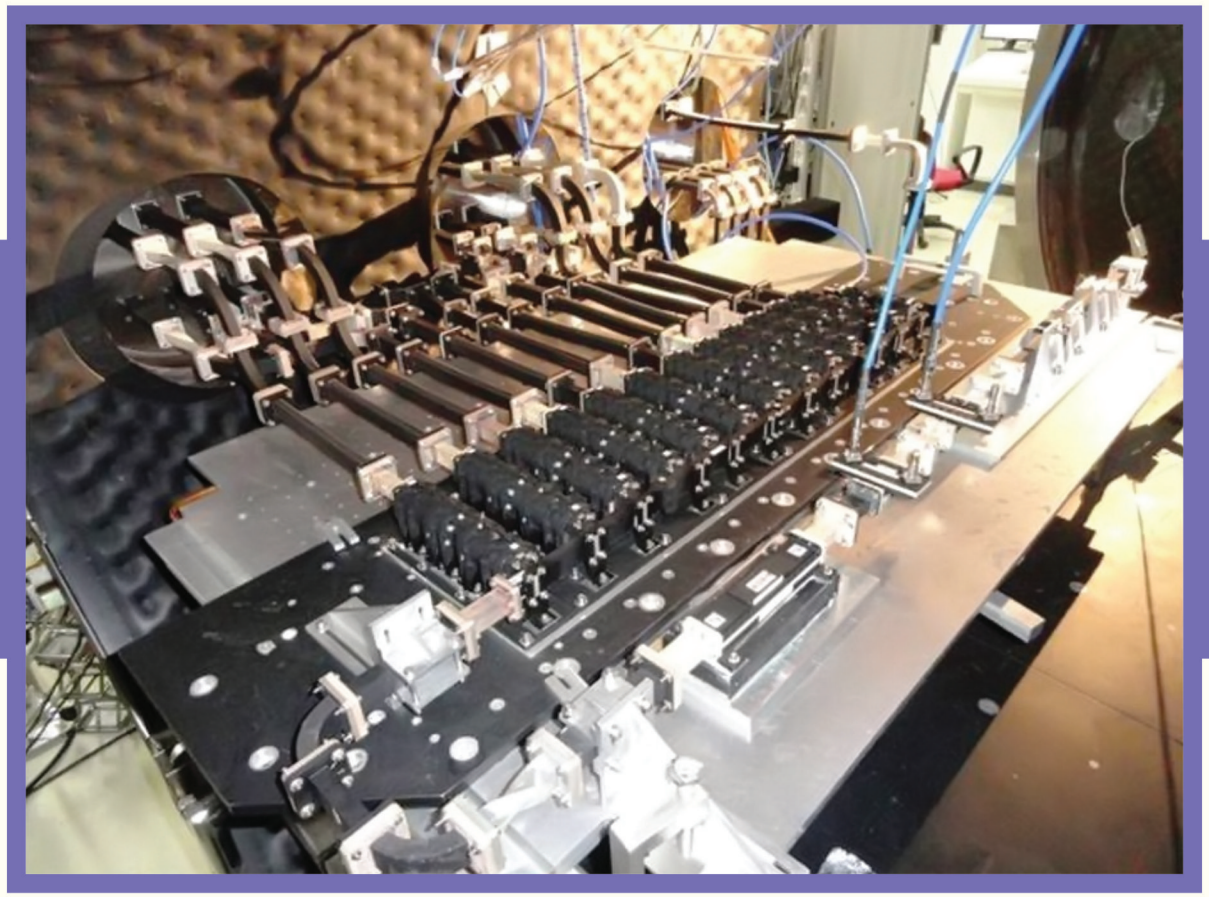
SAC is currently organized into the following major Areas, Groups and Divisions:

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

In addition, administrative divisions deal with Personnel & General Administration, Purchase & Stores, Accounts & Finance, etc.

Satellite Communications Technology and Applications

Payload development activity at SAC was started with the India's first experimental communication satellite APPLE. Since then SAC is involved in the Conceptualization, design & development of advanced communication systems. About 48 transponders (GSAT-16, highest transponder count on single satellite so far wherein 48 transponders in C, C –Ext, Ku band and 2 Ku Beacon Tx) are added to the INSAT fleet in the last year. GSAT-15 with 24 Channel High Power Ku Band FSS transponders was delivered for spacecraft integration. GSAT-9 with 12 Ku Band transponders was also delivered for spacecraft integration. GSAT-11 hardware realization is in progress. Payloads include 16 Spatially separated user beams in Ku-band, 4 spatially separated Hub beams in Ka-band, Ka x Ka link (125 MHz BW) across two hub beams and total throughput is approximately 10 Gbps (for FSS & Broadband). GSAT-19 payload was configured with Ka, Q, V bands and optical transponders. It provides a platform for advanced technology experiments. Hybrid RF-Optical link is configured to get enhance availability and would provide high data rate of 100 Mbps (with RF-optical links) / 1 Gbps (with Optical-Optical links). Ka- Band high throughput satellite is a multi-beam satellite with both hub links and user links in Ka-band and it would provide broad-band services to home users & commercial users over Indian Region. GSAT-20 is advanced multi-beam Geo-mobile satellite to provide services to hand-held type terminals over Indian region. A concept for flexible (in orbital location, polarization, frequency plan, routing, & bandwidth allocation) communication payload are being configured with transponders in S, C and Ku bands. Assembly, Integration and delivery of payloads for INSAT-3DR and IRNSS-1F are in progress. Sub-system development of GSAT-11, GSAT-17, GSAT-18 and GSAT-7A Communication Payloads are under progress.



GSAT-15: Ku-Band 13 Ch-OMUX, PIMP Filter & Tx Coupler Test

In the area of antenna systems, SAC has developed various types of antenna systems for earth stations, for INSAT and GSAT satellites etc. All four SAC-designed antennas integrated on CREW module successfully demonstrated communication with ship borne and SHAR earth station during Crew Module Atmospheric Re-entry Experiment (CARE) mission conducted during GSLV MARK III launch test.

Beginning with the establishment of the first Experimental Satellite Communication Earth Station (ESCES) in 1966 at SAC to Maitri in Antarctica, SAC has built many earth stations including the one at the Master Control Facility at Hassan. Delhi Earth Station (DES) provides Type-D & Type-C INSAT Mobile Satellite Services, DMS VPN network services and Ka/Ku-band propagation studies. BES–Bopal Earth Station facility at Bopal SAC Campus caters to EUMETCAST and VHRR data reception from INSAT series of Satellites. Ahmedabad Earth Station (AES) is mainly involved in SATCOM based operations and Experiments including Special events at SAC main campus and Bopal campus through BES. It supports Space-Net based Video Conferencing Facility, VHRR data reception, SATCOM course under CSSTEAP.

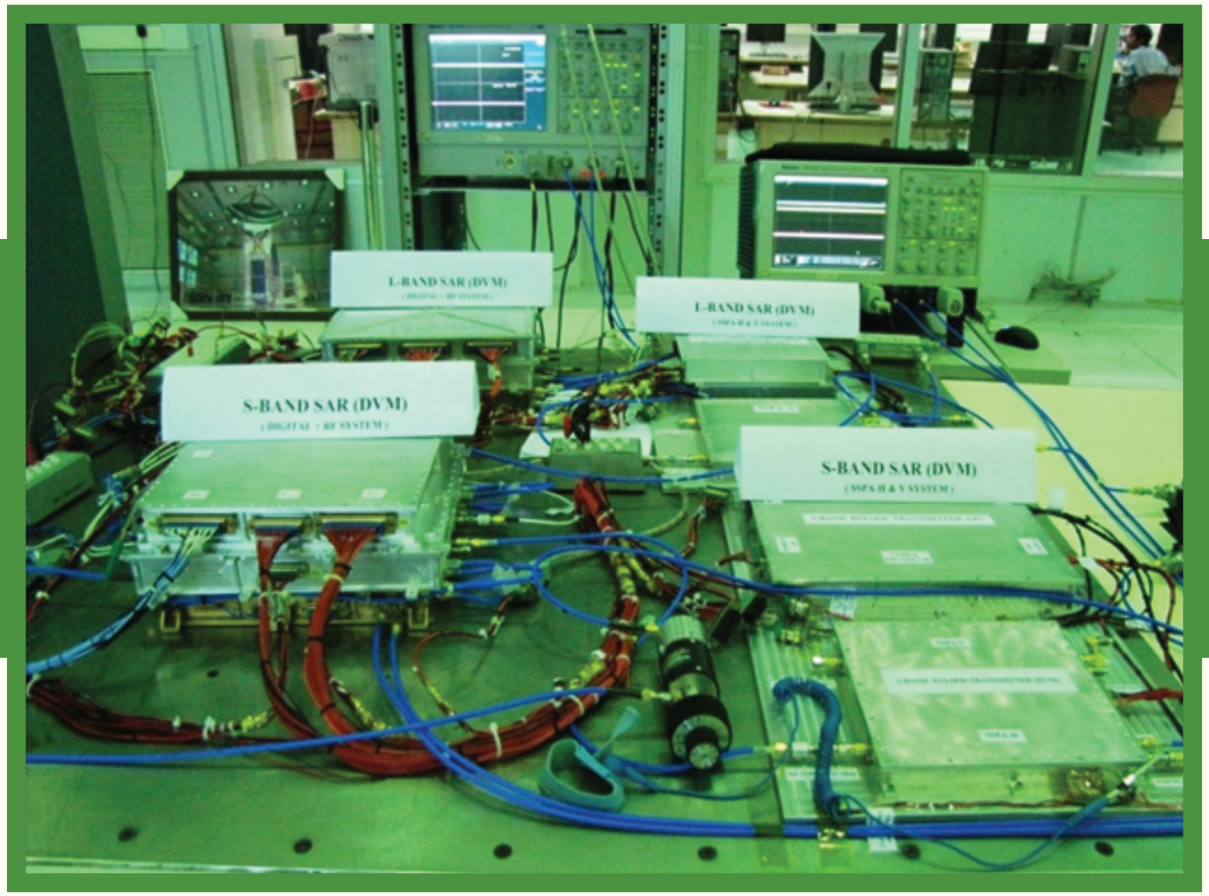
Ground system development for GSAT-11 is Planned with eight 9.2m Ka band Hub & four Beacon transmitters and User terminals in Ku band. SAC has undertaken a major applications project viz., EDUSAT applications Project for country-wide education via satellite. More than 33000 installations of user terminals for tele-education are operational in the country. SAC is also pursuing Telemedicine and extending communication support for Disaster management in the country. Another major new application will be the satellite based navigation support for civil aviation in the country under GAGAN project.

Under GSAT-6 Applications, evaluation of Broadcast Receiver (Terminal development) from 1 MSPS to 5.5 MSPS, Portable Multimedia Terminal (Testing of FPGA modem with signal strength indication), Reporting Terminal, was done. Also, Reporting service Hub base-band system was carried out.

Remote Sensing Technology Development

SAC plays a very important role in the Remote Sensing programme. Payload development was started with balloon experiments followed by aerial photography for remote sensing. In the last four decades there is significant development in the Optical, mechanical & electronic systems. Detectors have great improvements in terms of number of pixels from the early 2000 pixel to 12000, pixel size reduction from 13 micron square to 7 micron square.

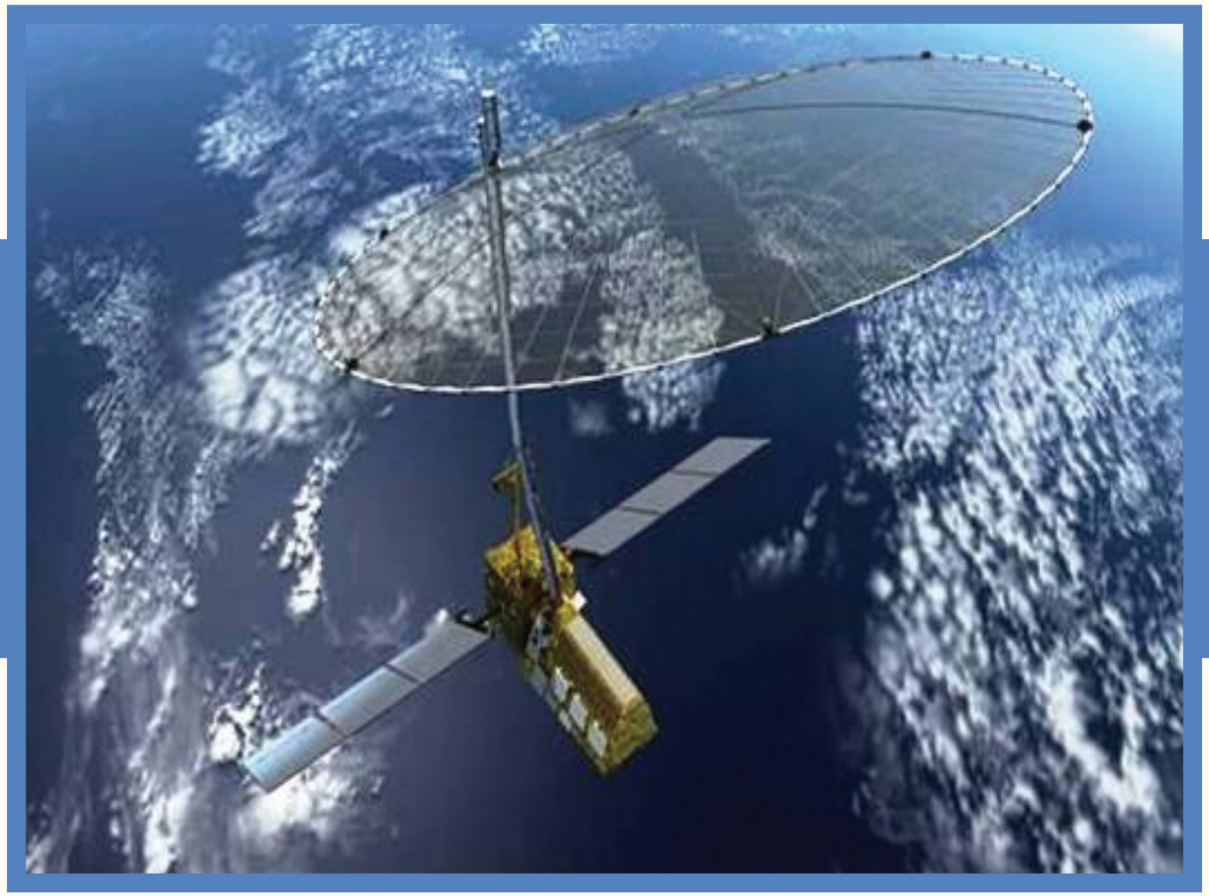
Three Electro-optical instruments: Terrain Mapping Camera-2 (TMC-2, Imaging IR Spectrometer (IIRS) and Rover Imager are being developed; DVM checkout of Dual Frequency L & S band mini-SAR was completed & FM development is in progress for Chandrayaan-2 mission.



Dual-Frequency (L&S-band) SAR for Chandrayaan-II Orbiter : DVM Integrated Test Set-up

The payloads for GISAT and Resourcesat-2A are under development. INSAT-3DR & S are follow-on to INSAT-3D and its subsystem developments are in progress. Development of Cartosat-2C and 2D, which provide 1 meter resolution multi-spectral imagery in continuous mode, is in progress. Cartosat 2C, the next payload in the Cartosat 2 series, will feature a four band multispectral camera as well as two event monitoring cameras in addition to the panchromatic camera. Significant work has been carried in the past year in the development of detector test benches for MX and Pan. OCEANSAT -3 has Two Electro-Optical Payloads -Ocean Colour Monitor (OCM) – 3 and Sea Surface Temperature Monitor (SSTM) – 1. Ocean Colour Monitor – 3 features 13 spectral channels for ocean colour science and atmospheric corrections, better radiometric performance, and SNR goal greater than 10; in addition to the above, Microwave sensors planned are Ku-band Scatterometer (Repeat) and mm-wave Temperature Sounding Unit (TSU). ScatSAT-1 on IMS-2: payload realization is in progress.

Dual frequency-SAR (L&S-band) is a Joint ISRO-JPL/NASA Mission; S-band SAR from SAC and L-band SAR, Feed-Structure from JPL. 24 TR-module configurations are based on Sweep SAR concept. NISAR Technical Interface Meet (TIM) was held a few months ago between SAC-ISRO and JPL-NASA. NISAR Science Workshop was conducted during November, 2014 at SAC with the primary objectives of informing and involving Indian scientific community about NISAR mission; exploring new applications of dual-frequency SAR data; and searching for collaborative opportunities in SAR applications. More than 300 participants attended this workshop.



NISAR Mission

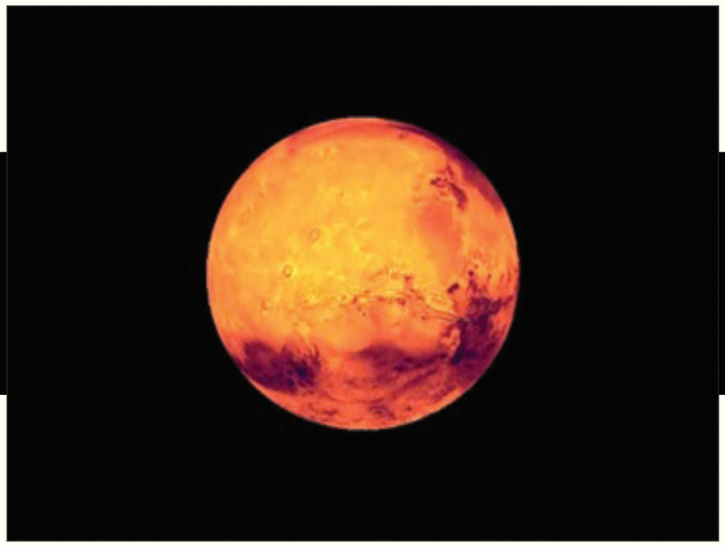
Ground Penetration Radar (GPR) was developed and delivered to Science team for snow accumulation studies at Antarctica. Its characterization was done at Snow Park and Manali glaciers.

During the 12th Five Year plan and beyond SAC is planned to develop 25 Payloads for 10 Mission (GSAT-6A, -7A, -11, -17, -18, -19E, -20, GISAT) in communication, 6 Payloads for IRNSS- 1F to 1G (L & S) in Navigation and 31 Payloads for 18 missions (Carto-3 Series, GISAT-1&2, Oceansat-3 series , RISAT-1 A, RISAT-2A, NISAR, RISAT-3).

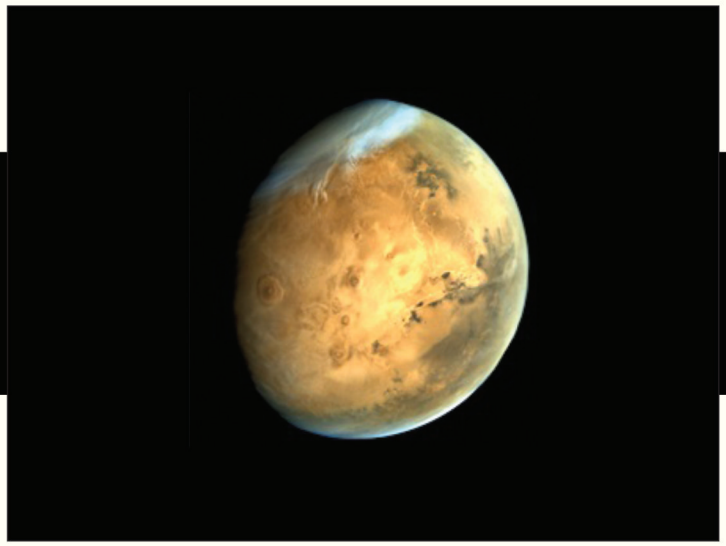
Remote Sensing – Image Processing and Applications

SAC has been developing the algorithms and the software required for processing and product generation of data acquired from IRS satellites. It involves the design, development, operationalization and maintenance of software for remote sensing data processing related to earth, planetary and astronomical observations for Indian as well as International user community. The software is transferred to NRSC, Hyderabad for operational dissemination of data products to users. In the area of remote sensing applications, SAC has made pioneering contributions in the field of agriculture, forestry, coastal zone management, fisheries, urban planning, watershed development, ground water prospecting, snow & glacier studies, oceanography and atmospheric studies.

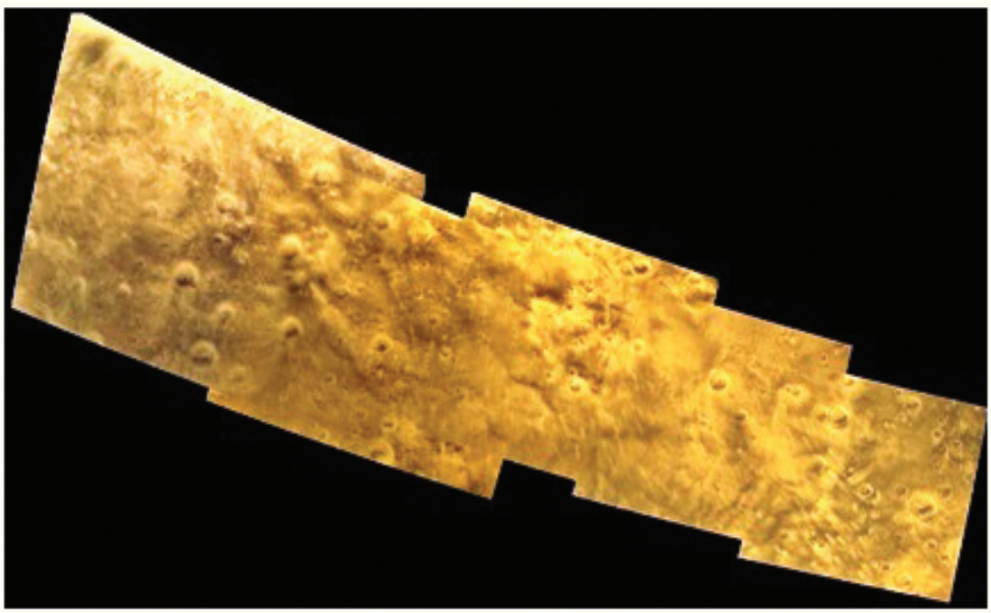
It is known that SAC delivered three Electro-optical Payloads (Methane Sensor for Mars (MSM), Thermal Infrared Imaging Spectrometer (TIS), and Mars Colour Camera (MCC)) for Mars Orbiter Mission (MOM). After the successful insertion of MOM into the Mars orbit, Mars Color Camera(MCC) was switched on. It took five images within an interval of 25 minutes. The first two images were taken with 133 microsec exposure time and other three with 400 microsec exposure time. MCC data of global Mars disc was been analyzed to monitor dust storms and north polar hood cloud condensate of CO2 on the higher latitude of Mars. MCC data over Syrtis Major region of Mars was analysed to geomorphologic features such as wind streaks, impact craters and basaltic terrains. MCC data for comet Siding Spring was acquired for close approach period and comet morphology was studied.



MCC Frame#1 27th September 2014 draped over MOLA DEM and Mars Digital Image Model



MCC Full Disc HDR 4th October 2014, at 74841 km



MCC Mosaic 27th September 2014 (5 frames)

ASTROSAT Data Products software involves QLD, Level-2 DP software, Archive, Browse and Dissemination and Support for ISSDC and POC (TIFR, IUCAA, RRI, IIA). CDR Completed. QLD Interface testing at ISSDC/BL4 was completed. Software developed and internal T&E completed for QLD and Level-2. Data Archival, Browse and Dissemination software is being developed for porting at ISSDC. SAC installed and operationalized RAPID, a web based software for near real-time INSAT-3D data visualization and analysis at IMD New Delhi, during IMD annual day in January, 2015.

In the area of remote sensing applications, SAC aims at identifying Earth Observational (EO) needs, development of techniques to model and analyse data for applications related to land, ocean, atmospheric and planetary sciences. It involves retrieval of biophysical and geophysical parameters from space borne imaging sensors, assimilation of remote sensing derived parameters, in-process modelling pertaining to interactions within the geosphere-biosphere system and atmosphere.

Shoreline Change Atlas of the Indian Coast (6 Volumes) in A-3 Size and soft copy in CD (6 CD + 1 containing all Volumes) were released by Chairman, Central Water Commission during inaugural function of the Brainstorming Workshop on Implementation of Coastal Management Information System (CMIS) at CWC, New Delhi in May, 2014. A presentation on salient results related to shoreline change mapping of the entire Indian Coast was made. Real time predictions of Cyclone NANAUK has been generated and disseminated through SCORPIO. Real-time prediction of cyclogenesis, cyclone track, intensity and storm surge was performed for cyclone HUDHUD using various models and information was disseminated through MOSDAC. Assimilation of INSAT-3D Atmospheric Motion Vector (AMV) Winds in global and regional weather prediction models was made operational since July, 2014. SAC is providing ocean (wave and surface currents) and atmospheric forecasts (winds and precipitation) to National Institute of Ocean Technology (NIOT) for their buoy operations in the Indian Ocean. An Automatic Weather Station (AWS) under Atmospheric Science Program (ASP) of ISRO-HQ has been installed on Rann-of-Kutchh site in CAL-VAL Laboratory at ISR Observatory, Desalpar. Telangana state has been added to FASALSoft configuration for forecast activities. Onsite software services were provided to NCFC-New Delhi to set-up new forecast activities. SAC Team went to disaster hit area in Srinagar, Jammu & Kashmir; provided DMS support and installed DMS VSAT nodes at four locations. All India three hourly weather forecast at locations having population greater than 50,000 has been released on MOSDAC. Time–module for AOI based data ordering of MEGHATROPQIUES and SARAL data was released on MOSDAC. SAR data was analysed for the Gangotri and Chhota Shigri glaciers during November, 2013 - June, 2014; also for Zemu glacier for August 2012. Basin-wise snow cover products using AWiFS time series data for the period October 2013 - June 2014 were generated and Snow cover Atlas for Indus for year 2013-14 was prepared. Preparation of 10 daily Snow Cover maps for 30 sub-basins for October 2013 - June 2014 was done; also Glacier Mass Balance estimation for 10 sub-basins for the year 2013 was done.

Fabrication and Test Facilities

In order to competently support the research & development activities, SAC has established excellent electronic and mechanical fabrication & test facilities. Facilities act as backbone for all the payload development like Mechanical Design, Development and Realization of Mechanical hardware; Subsystems development. New Technologies/Process development activities in the areas of Antenna, Electronic & Mechanical Services & Support have been taken up to cater the need of future payloads requirements. Some of the major facilities are: Microelectronic Facility for fabrication of Microwave Integrated Circuit (MIC) and Surface Acoustic Wave (SAW) devices, Payload Fabrication facility (PFF), Environmental Test Facility (EnTF) having hot and cold chambers, Thermovac chambers, vibration and shock test facility etc., Precision mechanical fabrication facility with computer controlled CNC and EDM machines, components screening facility and Bonded store. Computer Aided Design (CAD) facility established in the centre facilitates mechanical and electronic design and drawing generation.

Facility Augmentation

- 5 Ton Vibration Shaker System.
- 1 Ton shaper power amplifier.
- 16 Ch Digital Vibration Control System.
- LTCC Facility for miniaturisation of packaging for Microwave, mm Wave and Cooled EO detectors.
- Facility Augmentation Vision Measuring System.
- Mechanical Materials and Fasteners store in a New Building.
- E-beam evaporation system for thin film metallisation.
- Multi Layer Press for MLB facility.
- Multiple parameters environmental test system.
- Refurbished Salt Spray Chamber as per ASTM B117.

Indigenization and collaboration with Industry

- RF subsystems.
- IRNSS Atomic Clock Monitoring Unit.
- ETM of Rubidium Atomic Frequency Standard.
- Indigenous development of QDIP/DWELL Infrared Photo detectors: Q-dot modeling and spectral response simulation.

Collaboration with SCL

- Indigenous ASIC Designs, 0.18um CMOS Process as target Foundry.
- RF MEMS (X-band) Switch Development- design at SAC & Fabrication at SCL.
- RF CMOS (S-band) Development using 180 nm "Standard Logic" Digital Process- design at SAC & Fabrication at SCL (TowerJazz).

Systems Reliability

A strong Systems Reliability Area (SRA) recognizes need for continuous update of tools, techniques and procedures to be employed for assuring quality and reliability of increasingly complex and miniaturized payloads with very aggressive development schedule. Starting from design, reliability aspects are given utmost importance. Selection of components, their screening, circuit layouts, mechanical housing assembly design, wiring, mounting of components, test and evaluation, electromagnetic compatibility etc are the areas where SRA plays a critical role. SRA developed Test libraries and Design Pattern for automating the execution of tests on Micro controller Simulator. Automatic functional verification of FPGA Designs using advanced techniques developed. All the products & processes developed and followed at SAC are subject to stringent quality standards. SAC has taken firm steps towards Total Quality Management (TQM) by introducing Mechanical material, part and Product Data Management Systems (PDMS) for traceability.

Library and Information services

SAC has a well stocked library to support the R&D activities. Most of the functions are computerized and connected through the campus-wide network called SACNET to facilitate the users. Library also provides bibliographic and current awareness services. As its primary function to satisfy information needs of present and collection development for future, library procured, accessioned/registered, technically processed (Cataloguing, Classification and Display) it has been adding important documents in physical as well as electronic collection.

Library Facilities

Projects and Programme Management

To ensure advanced R&D activities and time bound projects with large budgets are executed systematically a management support group is established for project planning and monitoring. In addition, the functions related to patents & IPR filing, technology transfer & industrial interface, human resources development, management information systems, networks planning & operations as well as managing the IT facilities are carried out by a dedicated group. Progress monitoring of various ongoing projects in the Centre, independently and through various committees, assessing and coordinating the resource requirements, identifying critical paths and generating follow-up action items are crucial activities to keep the projects on schedule.

Future outlook

SAC will be developing communication and navigation payload systems to meet the increasing demand on capacity. It will be working on high power and higher frequency technologies. Considering the congestion & scarcity of the spectrum, SAC has started R&D activities for higher operating frequencies from Ka, Q, V, W to optical bands with flexibility in coverage, bandwidth and power. Work on navigation receivers is getting greater attention. The need for positioning based services has tremendously increased for civilian as well as strategic usage. In order to meet this high demand, Indian navigation satellite system IRNSS is getting established to provide accurate positioning with fast update rate for land/sea/air based users. Development of high resolution and hyper spectral sensors from LEO & GEO orbits will demand significant effort. Realisation of microwave systems for land, ocean and atmospheric observations are being taken up. Work on application activities to maximise the use of satellite based observations in the domains of land, ocean and atmosphere and providing short term alerts and warnings will continue to occupy our attention. In order to meet the future requirement of increased load, to overcome the congestion in existing labs, to meet the increased complexity of payloads, to implement the advanced technologies for design, manufacturing and testing and to develop the higher frequency subsystems, the Payload Fabrication & Test Facility (PFTF), Integration & Checkout facility, Large Thermovac & Vendor complex are under consideration.

CSSTEAP Course on Satellite Meteorology and Global Climate, at SAC, Ahmedabad (SATMET- 9)

A Report

Dr. B. Simon
Course Director

Ms. Yogini Vanikar
Course Coordinator

The Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP), affiliated to the United Nations is imparting training in various disciplines including "Satellite Meteorology and Global Climate (SATMET)". The Ninth Post Graduate Courses on Satellite Meteorology and Global Climate under the aegis of the UN affiliated CSSTEAP, is being conducted at Space Applications Centre (Bopal Campus), Ahmedabad during August 1, 2014 to April 30, 2015.

Seventeen participants from eight countries in Asia-Pacific region have been undergoing this course. They are mostly operational forecasters, meteorologist, and researchers in their own country. After they learn about satellite meteorology, they will impart training to their own officers in this subjects once they go back. The participants are from the countries like Bangladesh, India, Kazakhstan, Kyrgyzstan, Malaysia, Mongolia, Tajikistan, Vietnam.

The course commenced on August 1, 2014 at the Bopal Campus of Space Applications Centre (SAC), Ahmedabad. A joint inaugural function of the two courses i.e. the Satellite Meteorology and Global climate conducted by Space Applications Centre and the Space and Atmospheric Sciences conducted by Physical Research Laboratory was held at K.R. Ramnathan Auditorium, PRL on 4th August 2014. This function were presided over by Shri A.S. Kiran Kumar, Chairman ISRO, Dr. Y V N Krishna Murthy , Director CSSTEAP, and Dr A Sarkar, Dean PRL. Senior Officers from SAC and PRL graced the function.

A thoroughly detailed syllabus on the basis of Grenada and Frascati documents of UN-OOSSA was adopted for the course. The Board of Studies (BoS) Committee of Satellite Meteorology & Global Climate constituted by Director, CSSTEAP had modified the syllabus.

This SATMET-9 course has 2 semesters spread in 3- modules. The 1st module covers the fundamentals of Satellite Meteorology and Global climate, and 2nd module deals with Advance Concept of Satellite Meteorology, e.g., Geophysical Parameter Retrieval and Satellite Products and their application in NWP etc. The 3rd module, called Pilot project module (duration: 3 months) the participants have to do project on a topic relevant to their own country under the guidance of an expert scientist from Space Applications Centre, Ahmedabad.

During Module I and Module –II there were theory classes in the morning and practicals in the afternoon sessions. There were tutorials; weather discussion climate seminar and the performance of the participants were assessed through written, interactive sessions and practicals exercises. On successful completion of the Phase I, the participants will be given the PG diploma, and they can complete their PHASE-II project work in their own county for one year, and the work can be submitted to Andhra University for the award of M. Tech.

Recently we have incorporated new practicals, i.e., in Temperature and humidity profiles from Sounder data (INSAT-3D), Humidity profiles form SAPHIR sensor onboard Megha Tropiqus, SARL/Altika data Processing and related practicals from this course onwards, which was highly appreciated by the SATMET-9 students.

A one-week orientation module, covering various topics related to Space Technology, with special emphasis on Remote Sensing & GIS, Satellite meteorology, Satellite Communications and Space Sciences was introduced. Special lectures were delivered by eminent scientists in this module. The idea was to make all the course participants aware about the capabilities of Space Technology and related applications in various fields.

Faculty :

Faculty members for this course were drawn mostly from the Atmospheric and Oceanic Sciences Group (AOSG), SAC, Ahmedabad. A few scientists from the other Groups of Space Applications Centre, the Physical Research Laboratory, experts from India Meteorological Department (IMD) and Andhra University etc. also delivered lectures. Lectures were also arranged by foreign faculties/experts in the field i.e., Prof Dev Niyogi, from Purdue university, West Lafayette, USA, gave a lecture on land surface process and Climatology. Dr D G K Murty, Sr. Scientist, IMG inc. (working for NOAA/NESDIS), Maryland gave lecture on Satellite retrieval and validation, and details of Joint Polar Satellite System (JPSS). Prof R R Rao, director ICMPO, IITM gave lectures on Global climate Change and Arabian Sea warm pool. Prof Eric D Asro, Univ. Washington gave lectures on Ocean interaction with Tropical cyclones and Turbulence and mesoscale processes.

In addition to class room lectures during the morning hours, practicals using satellite data were conducted in the afternoon. The main work-horse for the practicals were data from INSAT and NOAA satellites. Microwave Data Sets – Mega Trophques – SAPHIR, SARAL/ALTIKA SSM/I, TRMM and GCM outputs etc. were extensively used by the course participants. During the first module the emphasis was on data / image interpretation with many case studies on clouds, tropical cyclones etc. The second module consisted basic of geophysical parameter retrieval, assimilation of Satellite Data in NWP, validations and their applications.

Special Facilities :

SATMET-9 course was held in the spacious SAC (Bopal) Campus. A special SATMET Laboratory with modular structure, uninterrupted power supply and networking was commissioned for the course with twenty PC's and a Server. This facilitated easy access to various satellite data sets, software etc. to each participant, particularly during their three months pilot project phase. Special terminals for e-mail purposes were provided, both in office and at hostel, which helped the participants in data downloading, browsing and also to remain in touch with their families/office.

A versatile software package "ERDAS, MEAS, IDL, MATLAB" on each terminal provided much needed standardization in data processing (INSAT, MT, NOAA, MODIS etc.) to all the participants. This would help them immensely in the continuation of the project back home. A set of three volumes of lecture notes prepared especially for the SATMET course comprised the main resource material. These were distributed in the beginning itself to all the participants.

A separate CSSTEAP Network was installed with access from Class room, laboratory and hostel. With this network the students could access the study materials (Class room lectures) both in word and in presentation form, this facilitated them to recall the class room lectures again and benefited particularly the students with English language problem. Special English classes were held by professionals near Bopal campus.

Hostel accommodation was arranged in the International hostel with good living facilities and with attached Kitchenette. Canteen facility was provided to the participants in both Technical campus and Hostel. For entertainment DTH system was provided to them in their rooms. 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-months course.

Seminar, Tutorials and Map Discussions :

Each participant gave a number of seminars during the Course, related to Climate and meteorological problems affecting their region and also the topics related to their Pilot Projects. This exercise helped them greatly to improve their presentation skills. 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. Participants enjoyed these sessions meant to enhance the problem solving capabilities.

Technical Visits :

During the 9 months Course, the participants visited some of the important Institutions / Laboratories in the country to have a first hand experience of the utilization of satellite data in an operational environment. The technical tours included visits to:

- Doppler Weather Radar (DWR), Chennai
- Andhra University, Visakhapatnam.
- Satish Dhawan Space Centre, Sriharikota
- National Remote Sensing Centre, Hyderabad
- Indian National Centre for Ocean Information Services (INCOIS) and Tsunami warning Centre, Hyderabad
- Field trip to Mount Abu Observatory

These tours were so designed that the participants not only had an opportunity to visit excellent facilities of ISRO and other National Organisations, but also get familiarised with the cultural heritage, diversity and natural scenic beauty of various parts in India.

Pilot Projects :

The candidates learnt a lot during the 3 months Pilot-Project-about formulation of a problem of relevance to their country, specifying and acquiring data, execution, and communication both orally and in writing. The variety of coverage of themes can be appreciated from the list of Projects given in this Memoir.

The Pilot Project could be listed in following broad topics :

- ❖ Assimilation of satellite data and impact studies using WRF model and Ocean Circulation model.
- ❖ Sounding products using INSAT-3D / AIRS and MODIS data and its validation/Applications.
- ❖ Cryo-sphere (assessment of change)/ variability of green house gases.
- ❖ Mesoscale convective studies using satellite data.
- ❖ Fog/ Nowcasting/Rainfall and tropical cyclone studies using satellite data.

The topics for one year Project work were identified after several discussions with the participants. The field of interest of the participants, the needs of the sponsoring organisations and the facilities available in the countries of participants for supporting the project work were taken into account while deciding the project.

Acknowledgements :

It has been possible to conduct the 9th PG course on Satellite Meteorology and Global Climate at Space Applications Centre, 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. Thanks are due to DWD and ITND for providing all the help for the computers and internet. We thank SAC and Bopal Administration (especially B N Panchal and his team), and Controller SAC, CMD and his team, purchase, P & PR, Medical Officer, Vikramnagar colony for the support extended to the course participants. We thank Shri Kiran Kumar, Chairman ISRO, and Shri Tapan Misra, 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)

Sub - 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
Sub - 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
Sub - Module 1.3	**Image Processing, Interpretation and GIS**
Section 1-3 DIP	Image Processing Techniques and Geogrphic 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 Theroy, 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 Forecasing
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 Lectures

Sub- MODULE 1.1 : CONCEPTS IN METEOROLOGY AND CLIMATOLOGY

Section 1-1-MET Basics Concepts of Meteorology, Climatology and 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 and Statistical, Computational Techniques for Satellite Meteorology

- Matrices & Vectors
- Partial & Total differential equation
- Integral & Derivatives
- Basic Concepts of Statistics
- Basics of Computer Programming

Section 1-1-MATH Mathematical and Statistical, Computational Techniques for Satellite Meteorology

- 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 Concepts in 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 Met Satellites- Orbits, Instrumentation

- Orbits and Navigation
- Operational Polor-orbiting satellites
- Operational Geostationary Satellites
- Other Satellites
- Satellite data Archive

Sub - MODULE 1.3 : IMAGE PROCESSING & INTERPRETATION

Section 1-3-DIP Image Processing Techniques and Geographic Information System (GIS)

- Map Projection
- Satellite Positioning System
- Image Registration, Radiometric & Geometric Correction
- Image Classification
- GIS

Section 1-3-WF Image Interpretation in Meteorology and Weather Forecasting

- Satellite Imagery
- Spectral Properties
- Identification of Meso Scale Systems
- Tropical Synoptic Systems
- Extra Tropical Synoptic Systems
- Radar Meteorology

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 Applications in Meteorology and Weather Forecasting

- Onset of Monsoon
- Intra-Seasonal & Inter annual variability
- Tropical Cyclones
- Extra Tropical Cyclones
- Weather Systems related to Tropics & Mid-latitude interaction
- Agrometeorological Applications
- Drought Monitoring
- Air-Sea Interaction

Section 2-2-NM Satellite Data Assimilation in Numerical Models

- ❖ 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-SC Short Term Climate Variability

- ❖ El-Nino & Southern Oscillation
- ❖ Cloud Climatology
- ❖ Land Surface Changes
- ❖ Radiation Budget
- ❖ Ozone and other Trace Gases
- ❖ General Circulation Models & Regional Circulation Models

Section2-3-LC Long Term Climate Change

- ❖ Climate Change
- ❖ Geosphere – Biosphere interaction
- ❖ Green House Effect & Global Warming
- ❖ Hydrological and Carbon Cycle
- ❖ Changes in Cryosphere
- ❖ Future Climate Scenario & Satellite Missions

Section 2-3-ESI Environment Issues and Societal Impacts

- ❖ Oceanic Biological Productivity
- ❖ Coastal Zone Environment
- ❖ Pollution
- ❖ Disaster Management
- ❖ Mass Communication

LIST OF PRACTICALS

Module I : Operational Meteorological Satellite Data Handling & Applications

Sr. No.	Title
1.	Computer Orientation I: Familiarization of SATMET Labs, systems & Networks, Visit to MOSDAC & AWS.
2.	Computer Orientation II: Visualisation tools- LINUX, GRADS, Ferret, MIAS, IGIS, Fortran
3.	Computer Orientation III: ERDAS Familiarisation, MIAS – Advance
4.	INSAT-VHRR data handling, cloud characteristics, feature extractions and applications.
5.	NOAA-AVHRR Data Processing – Feature extractions and Applications
6.	Estimation of Daily & weekly Rainfall using INSAT-VHRR data – Arkin's Technique.
7.	Meteorological Data Processing
8.	Cloud Motion Vectors using INSAT-VHRR data and computation of Divergence & Vorticity.
9.	Visualization & analysis of Meteorological Data – Demo of Application of satellite data in tropical cyclone.

Module II: Remote Sensing of Geophysical Parameters & Numerical Modelling Applications

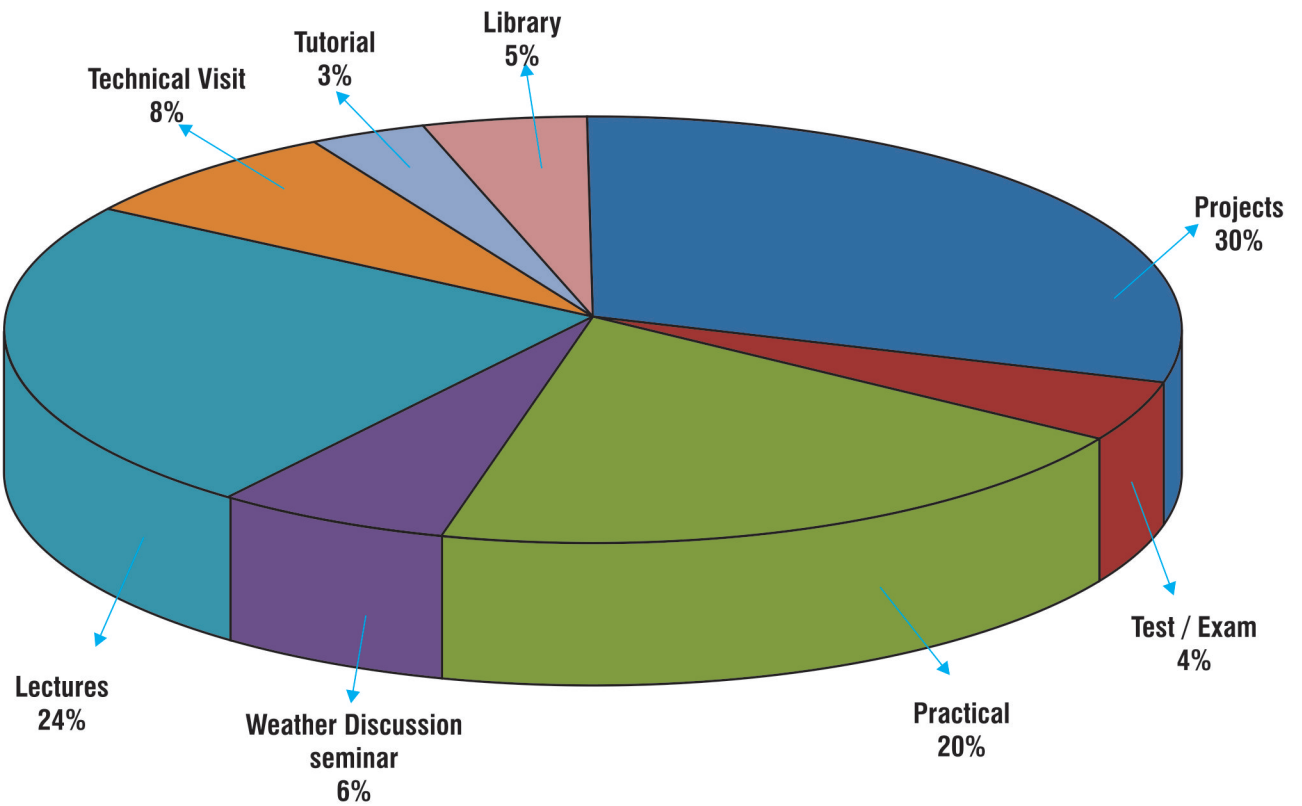
Sr. No.	Title
1.	Temperature and Moisture profiles from INSAT-3D/NOAA-ATOVS/AIRS/IASI data and validation.
2.	SST from INSAT-3D/MODIS/NOAA-AVHRR data and study of Ocean Thermal features.
3.	Geophysical Parameter Retrievals from MW Radiometer data/Megha Tropiques (MT)
4.	Humidity Profiles from AMSU-B/ SAPHIR-MT.
5.	(a) Climate Simulation Demo. (b) Fog monitoring
6.	Agromet Application.
7.	Assimilation of Satellite Data in Numerical Weather Prediction (NWP) Models.
8.	SARAL/AltiKa Data Processing & Applications.
9.	Cloud Radiative Forcing (CRF) using Satellite data [SCRab/ERBS/CIRRUS]

CORE PERSONNEL OF THE COURSE

Course Director : Dr. B. Simon
Course Coordinator : Ms. Yogini V. Vanikar
Pilot Projects : Dr. Rajkumar Sharma

BREAK UP OF COURSE HOURS

BREAK UP OF COURSE HOURS (Satmet-9)



LIST OF FACULTY MEMBERS

AOSG/DWD, SAC

Theory

1. Dr. A.K. Mathur
2. Dr. B.S. Gohil
3. Dr. B. Simon
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5. Ms. Pushpalata Shah
6. Dr. C.M. Kishtawal
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8. Dr. Rashmi Sharma
9. Dr. Rajkumar
10. Dr. R.M. Gairola
11. Dr. Sandip Oza
12. Dr. V. Sathiyamoorthy
13. Dr. Sanjib Deb
14. Dr. M. P. Oza
15. Dr. Abhineet Shyam
16. Dr. A.K. Varma
17. Dr. Randhir Singh
18. Dr. S.K. Basu
19. Dr. Neeru Jaiswal
20. Dr. Neeraj Agrawal
21. Dr. Kaushik Gopalan
22. Dr. Bipasha Paul Shukla

Practicals

1. Ms. Yogini Vanikar
2. Shri Dipak Maroo
3. Shri Mahesh Patel
4. Mr. Rishi Gangwar
5. Dr. Sasmita Chaurasia
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7. Mr. Ghansham Sangar
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9. Ms. Ruchi Modi
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15. Mr. Nitesh Kumar Kaushik
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19. Ms. Ispita Dey
20. Dr. Smitha Ratheesh
21. Mr. Abhisek Chakraborty
22. Mr. Prateek Kumar
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24. Mr. Deeraj Shah (JRF)
25. Ms. Maya Suryawanshi (JRF)
26. Ms. Swati Bhomia (JRF)
27. Mr. Buddhi Prakash Jangid (JRF)
28. Ms. Neha Rajput (JRF)

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2. Dr. R.P. Singh
3. Dr. Shashikant A. Sharma
4. Dr. Nitant Dube
5. Dr. Prakash Chauhan
6. Dr. R.K.Bhattar
7. Smt. Rachna Patnaik
8. Dr. R. Ramkrishnan
9. Dr. Mehul Pandya

ISRO/Department of Space (DOS)

1. Dr. George Joseph, Ex., Director, CSSTEAP
2. Dr. R.R. Navalgund, Ex., Director, SAC, Bangalore
3. Dr. P.C. Joshi, Ex., SAC, Ahmedabad
4. Dr. A. Sarkar, Ex., SAC, Ahmedabad
5. Prof. Harish Chandra, PRL, Ahmedabad
6. Dr. Somkumar Sharma, PRL, Ahmedabad
7. Dr. S.Ramchandran, PRL, Ahmedabad
8. Prof. A.K. Singhal, PRL, Ahmedabad
9. Prof. Shyamlal, PRL, Ahmedabad
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2. Dr. R. Suresh, IMD, Chennai
3. Prof. S.S.V.S Rama Krishna, Andhra University
4. Prof R R Rao, Andhra University
5. Dr. U.S.De, Pune
6. Dr. P.C.Pandey, IIT, Bhuvneswar

Foreign Guest Faculty

1. Prof. Dev Niyogi, USA
2. Prof. Eric Asaro, USA
3. DR. D G K Murty, USA

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Sr. No.	Name	Organization
01	Mr. Muhammad Arif Hossain	Bangladesh Meteorological Department, **Bangladesh**
02	Mr. Md Omar Faruq	Bangladesh Meteorological Department, **Bangladesh**
03	Lt Cdr Naveen Krishna Chandra	Indian Navy **India**
04	Mr. Sanjeev Dwivedi	SRM University, **India**
05	Sqn Ldr Sarungbam Denny Singh	Indian Air Force **India**
06	Mr. Abayev Nurlan	RSE, kazhydromet **Kazakhstan**
07	Mr. Akhmet Sulemenov	RSE, kazhydromet **Kazakhstan**
08	Ms. Guldana UatKhan kyzy	RSE, kazhydromet **Kazakhstan**
09	Ms. Saliyeva Kamar	RSE, kazhydromet **Kazakhstan**
10	Mr. Rasul-Akhun Baikhadzhaev	Department Of Meteorology, **Kyrgyzstan**
11	Mr. Syed Mohd Faiz Bin Syd Mahusin	Malaysian Meteorological Department, **Malaysia**
12	Ms. Battsetseg Buyantogtokh	Institute of Meteorology, Hydrology and Environment **Mongolia**
13	Ms. Garamkhishig Gansuren	Center for Meteorology Hydrology and Environmental Monitoring in Dornod Province, **Mongolia**
14	Ms. Oyunchimeg Otgon	Institute of Meteorology, Hydrology and Environment **Mongolia**
15	Mr. Akhmedov Faridun	NegmatulloevichWeather Forecasting Department **Tajikistan**
16	Mr. Faridun Sobirov	State Administration of Hydrometeorology **Tajikistan**
17	Ms. Doan Thi Thu Ha	Center for Marine And Ocean Atmosphere Interaction Research, Institute of Meteorology, Hydrology and Environment (IMHE) **Vietnam**

Participants Profile and Pilot Project

Mr. Muhammad Arif Hossain
Bangladesh

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Born in Jhalokathi at Southern part of Bangladesh, he has completed his Post Graduation in Applied Mathematics from Dhaka University, Dhaka, Bangladesh. He joined Bangladesh Meteorological Department as an Assistant Meteorologist in 2008. He has completed Class-II Forecaster's course for one year from the Training Institute of Bangladesh Meteorological Department. He has served as an aviation forecaster & weather forecaster for about three years. At the time of joining SATMET-9 course, he was working as a meteorologist & weather forecaster at Storm Warning Center, Bangladesh Meteorological Department since about two years. He has also undergone a training course of one month on Integrated Flood and Analysis System(IFAS) in International Centre for Water Hazard and Risk management (ICHARM) at Tsukuba, Japan in 2013.

He is, undoubtedly, the most humble, simple and honest person in the course. Very helpful and always wears a smile. He also possesses a very sound knowledge of meteorology. He bought about 100 saris for his relatives!!.

Mr. Muhammad Arif Hossain
Meteorologist & Weather Forecaster, SWC, BMD
Guide: Mr. Abhisek Chakraborty, AOSG/SAC

Storm surge prediction over coastal regions of Bangladesh using ADCIRC model

Tropical cyclone is intense low pressure system that forms in the tropics and is one of the greatest natural hazards in the world. The damages from land-falling cyclones are mainly due to three factors: heavy rain, strong winds and storm surges. Among them, storm surges associated with severe cyclonic storm are the most vulnerable for the coastal habitants. The geographical location of funnel-shaped Bangladesh coasts presents favorable conditions for the genesis of tropical cyclone with high frequency and so with the associated storm surge and high wave events. In such a scenario, timely prediction and warnings of storm surges are critically intended for the coastal authorities as well as for the local government bodies. Hence, under the pilot project of SATMET-9, an attempt has been made to study the predictability of storm surges over the coastal regions of Bangladesh using a numerical storm surge model known as Advanced CIRCulation (ADCIRC) model.

The model was configured for the Northern part of Bay of Bengal extending from 86E to 94E in longitude and from 16N to 24N in latitude. The ADCIRC model provides the flexibility of using triangular meshes to represent the irregular coastal boundaries in a realistic way. In this study, we have used this flexibility to define our model domain which consists of 9481 nodes and 18383 triangular elements. We have chosen the case of severe cyclonic storm Aila (23-25 May, 2009) to simulate the associated surges using ADCIRC in hind cast mode. The meteorological forcing for the model were provided from National Center for Environmental Prediction (NCEP) analyzed data. The simulation period was for the entire May month of 2009. In order to assess the quality of our simulation, we have validated the simulated surges against the Merged Sea Level Anomaly (MSLA) observations from multiple Altimeters (www.aviso.oceanobs.com). The validation result shows around 40 cm errors in the simulation at the time of landfall of the cyclone and an overall Root Mean Square Error (RMSE) of around 10-20 cm over the entire domain.

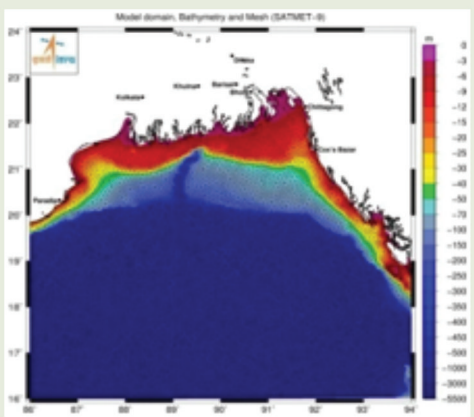

Fig I. Model domain, mesh structure and bathymetry

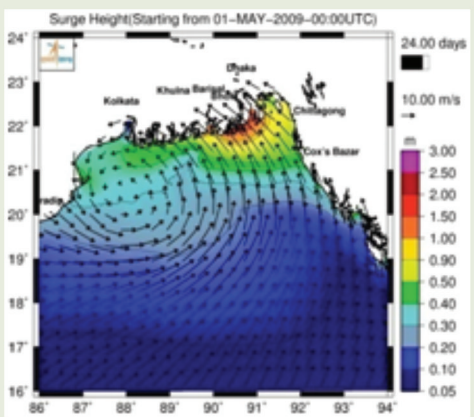

Fig II. Surge Height on 24 May, 2009

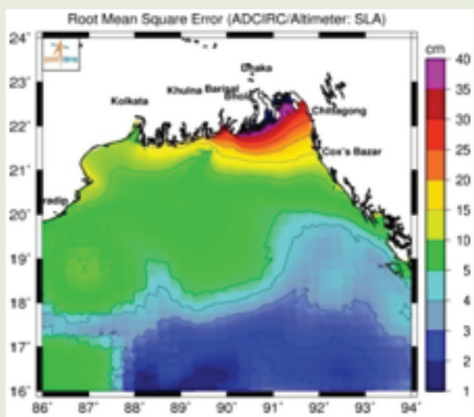

Fig III. Root Mean Square Error of sea level anomaly during cyclone 'AILA'

Mr. Md Omar Faruq
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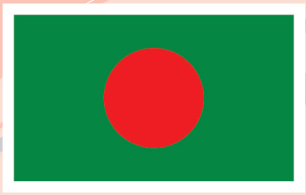
Born on 30th June 1978 in Patuakhali, Bangladesh and living in Dhaka, Bangladesh.Completed graduation and post-graduation in Physics at National University, Gazipur, Bangladesh. Joined Bangladesh Meteorological Department in 2008 and currently working in Hazrat Shahjalal International Airport (HSIA), Dhaka, Bangladesh as an Aviation Forecaster. He is attending his second course at ISRO. Earlier, he completed the 2nd International Training Course on Navigation and Satellite Positioning System (NAVSAT-2) in 2013 for four weeks between 17th June to 12th July from CSSTEAP.

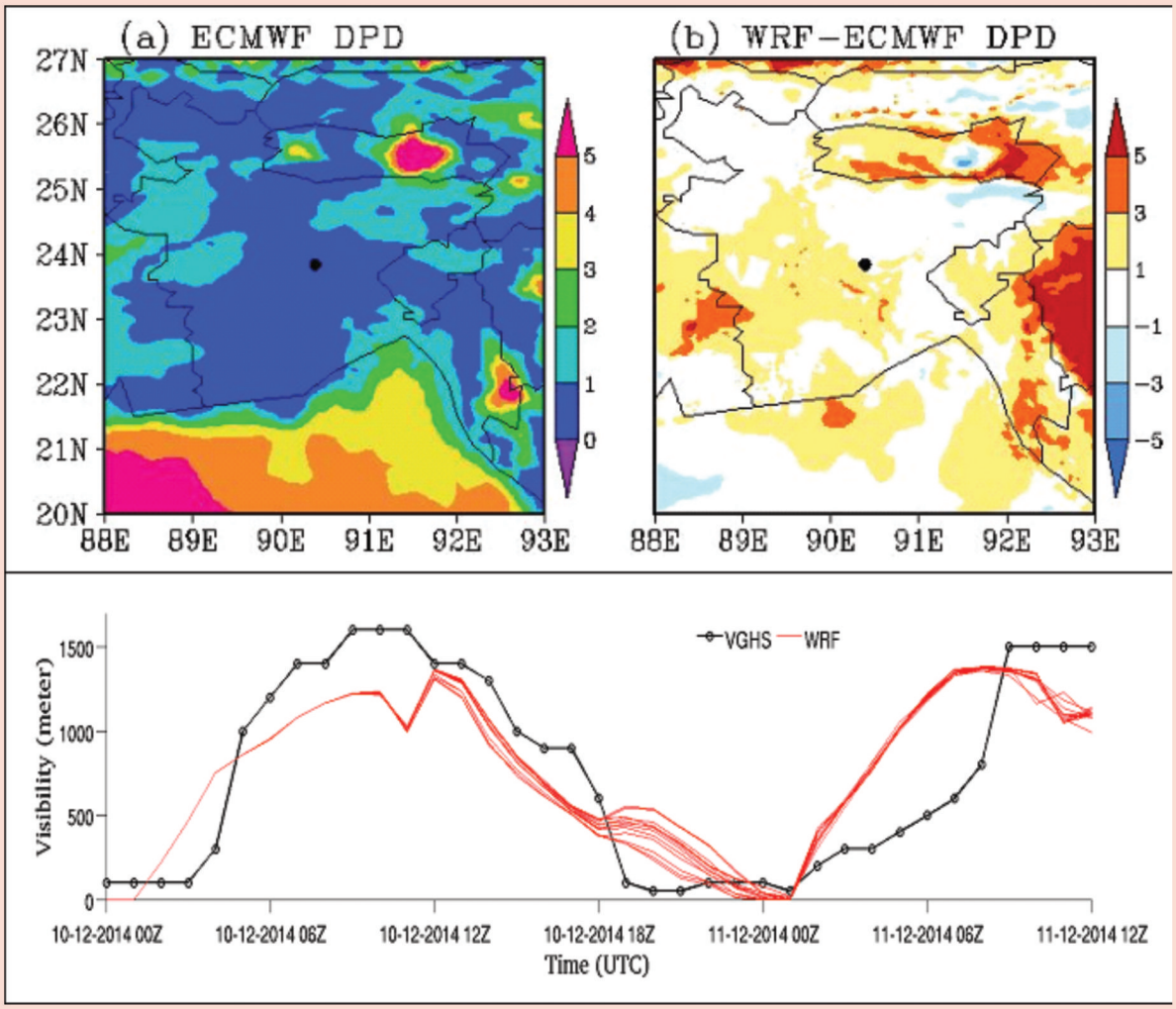
An active, kind, studious, and nice gentleman. He is known as the “Riceman” because he prefers rice to everything. He has a Small server inside his brain that can solve complicated mathematical equations. His favorite phrases are 'different different' ; ' Yaa Yaa'.!!



Mr. Md. Omar Faruq
Meteorologist, Bangladesh Meteorological Department
Guide : Dr. Prashant Kumar, AOSG/SAC

Fog Prediction using WRF model over Bangladesh Region

The economic losses due to the presence of fog on aviation, marine and land transportation are well known and comparable to extreme weather events like heavy rainfall, cyclone, etc. Fog limits the visibility and thus affects human activities that rely on good visibility conditions. The Weather Research and Forecasting model with different micro-physics schemes is used in this study to evaluate the sensitivity of micro-physical parameterization on the simulation of dense fog episode. Initially, existing visibility algorithms (RUC, FSL, and SW99) are verified over the HSIA airport, Dhaka. These algorithms are unable to predict fog event. Further, an empirical relation is prepared using in-situ visibility and ECMWF model analyzed temperature and humidity during December 2014. This empirical relation is used for visibility prediction in WRF model. WRF model predicted visibility is able to capture the onset and withdrawal of fog event. Moreover, withdrawal of fog is very steep in model prediction as compared to in-situ. No major impact is seen on visibility prediction using different micro-physics in the WRF model. WRF model is able to predict dew point depression, temperature and relative humidity accurately over the Bangladesh region in 24-h prediction when compared with ECMWF final analysis.



Lt Cdr Naveen Krishna Chandra
India

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Born in Guntur district of Andhra Pradesh, this naval officer earned Masters degree in Chemistry from Sri Satya Sai Institute of Higher Learning, Prasanthinilayam, Andhra Pradesh and M.tech in Materials Science & Technology from Institute of Technology, Banaras Hindu University, Varanasi before joining Indian Navy as Commissioned Officer in 2003. After joining Navy, he accomplished Masters in Meteorology from Cochin University of Science and Technology (CUSAT), Kochi. He started his naval career as Instructor at INS Chilka, Orissa and then switched to operational side by becoming Met officer and serving as aviation forecaster at INS Dega, Visakhapatnam and INS Hansa, Goa. He was also involved in 'Venue Specific Forecasting' project undertaken by India Meteorology Department (IMD) during the Common Wealth Games (CWG) - 2010 held at New Delhi. Before coming for the course, he was working at Indian Naval Meteorological Analysis Centre (INMAC), Kochi.

Real patriot of his country. He is hardworking and studious. Curious to know many things in the theory class as well as in the Practical session. His favourite word is “CORRECT !!!”.

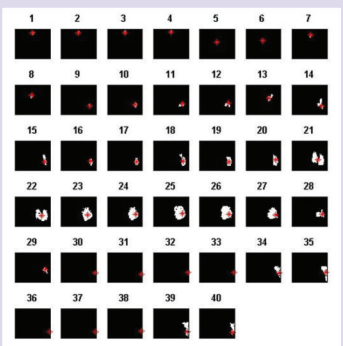
Lt Cdr Naveen Krishna Chandra
Meteorological Officer
Guide : Dr. Bipasha Paul Shukla, AOSG/SAC

Nowcasting of Mesoscale Mesoscale Convective System Using Satellite Data

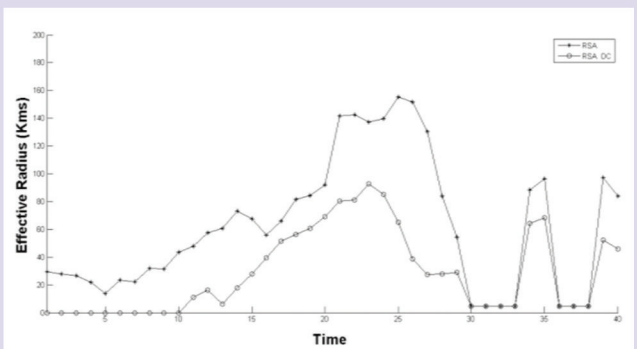
Cumulonimbus (CB) clouds are a severe hazard to aviation, due to the likelihood of: severe turbulence, severe icing, micro- bursts, generating squalls or gust fronts giving severe low-level turbulence, lightning, high liquid water content, eg rain water content, hail. Localised convective activity is frequently observed during Pre-monsoon and Post Monsoon seasons in India. Whilst individual Cumulonimbus clouds may have a lifetime of 1½ hours, the most intense Cumulonimbus development and thunderstorm/lightning activity is associated with Multi Cell Convective systems which may develop further into super cells. Such systems are long lived due to the spawning of daughter cells and may last for many hours. Nowcasting, which refers to forecasting for a very short time range (up to 6 hours) is useful for predicting the development and dissipation of such systems.

Satellite data, acquired from geostationary satellites provide valuable inputs for nowcasting due to their high spatio-temporal resolution. Scientists are continuously striving towards newer techniques to track and nowcast convective systems with higher accuracy and improved lead times. In this context, in the present study an image analysis technique i.e Source Apportionment (SA) algorithm has been applied for predicting individual convective systems over an air station using Kalpana-1 and INSAT3D satellite sequence of images. The algorithm uses neighborhood search criteria to extract contiguous convective pixels. The extracted pixels are then used to trace the evolution and predict the development of convective system, using some identified nowcasting parameters.

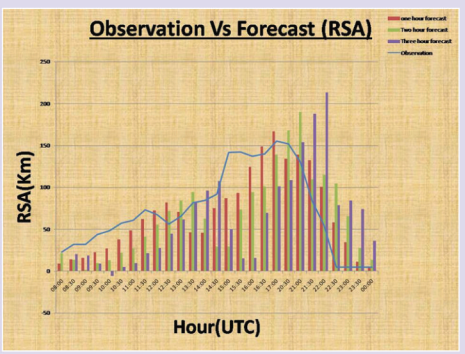
The present technique has been applied over a few air ports of Indian region for convective systems case studies during Pre and post monsoon seasons of 2013 and 2014. Tracking and nowcasting of the weather phenomenon is achieved by analyzing a few nowcasting parameters. The results of the study show that temporal variation of effective radii of convective systems and those of deep convective zones are suitable for identifying the mature stage while evolution of their slopes are good for identifying the dissipating stage. It is seen from the study that model is able to predict the mature and dissipation of a convective systems with a lead time up to 3 hours.



Thunderstorm at Kochi



Nowcasting Parameters



Nowcast Vs Observation

Mr. Sanjeev Dwivedi
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Born on 26 July 1984, brought-up in Punjab, India. This research scholar has completed Masters degree in Astronomy and Space Physics from Punjab University, Patiala in 2008 with gold medal. He has worked as a Physics Lecturer at Ramgarhia Education Group from 2008 to 2012. Presently pursuing his Ph.D. at SRM University, Chennai, India and working as a Senior Research Fellow in an ISRO – INSAT-3D project on - Low Level Monsoon Inversion study over the Western Arabian Sea using INSAT-3D satellite data. He is interested in developing new ideas which would be useful for the mankind. Hobbies are Reading, Swimming, Martial Arts and Yoga. Usually wakes up early in the Morning, thanks God for providing nice opportunities.

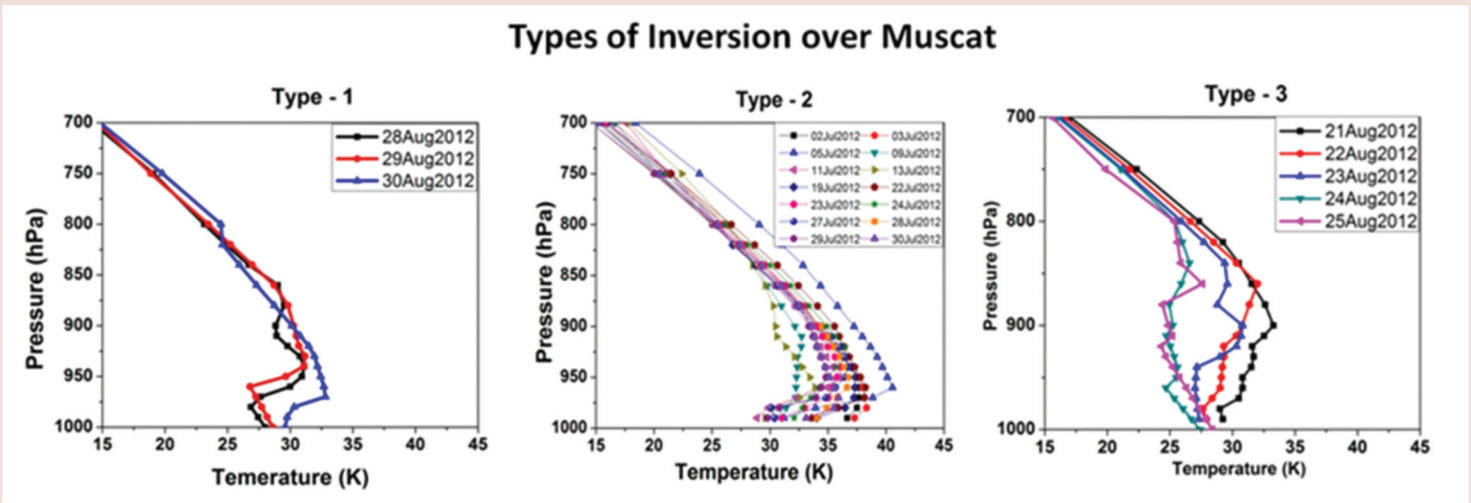
Very hardworking and friendly person. He rejoices in everything like an innocent child! But it doesn't mean that he is child. A very sensitive, caring and dedicated Person!

Mr. Sanjeev Dwivedi
Research Scholar, SRM University
Guide: Dr. V. Sathiyamoorthy, AOSG/SAC

A Study on the characteristics of the Arabian sea Lower Tropospheric Thermal Inversion using Radiosonde and Satellite Data

Over the regions of thermal inversion, temperature increases with height. Atmosphere is stable and clouds are unable to grow vertically over these inversion regions. Over the Western Arabian Sea, thermal inversion is seen at the lower troposphere during the summer monsoon season of June to September. Characteristics of this thermal inversion are studied using radiosonde data collected over two radiosonde stations located within the thermal inversion region (on the coast of the West Arabian sea) and compared them with satellite derived temperature data. Two stations considered for the study are (i) Muscat (28.5°N; 58.5°E) and Salalah (17.0°N; 54.1°E) both located in Oman. Two years (2012-2013) of radiosonde data collected from the Wyoming University are used for this purpose. Analysis of the radiosonde measured temperature profiles during the peak monsoon season of July-August suggests that the inversion pattern is highly variable on day-to-day basis over Muscat and nearly constant over Salalah. Three distinct inversions patters are identified over Muscat (Fig.1). The three types of inversions are: (i) [Type-1] Temperature decreases with height in a shallow region close to surface followed by an increase up to about 900 hPa and decrease thereafter (ii) [Type-2] Temperature increases with height from surface up to about 900 hPa and decrease thereafter and (iii) [Type-3] Multiple inversions with zig-zag patter up to about 850 hPa. Salalah showed most of times a similar inversion pattern with peak temperature around 950 hPa. Statistics of the occurrence of inversion types are generated for Muscat and Salalah.

Ability of the satellites in capturing the thermal inversions is examined using IASI data. The IASI data is able to capture the spatial pattern of thermal inversion over the Arabian Sea well. Limited validation of IASI temperature profile data over the two radiosonde stations is also attempted during the peak monsoon season of 2012 and 2013. Statistics of the comparison suggest good level of matching between IASI and radiosonde data over the thermal inversion region.



Sqn Ldr Sarungbam Denny Singh
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Born and brought up in Imphal, this Air Force officer is B.Sc. (Physics) from Manipur University, and M.Sc. (Physics) from Jamia Millia Islamia, New Delhi. Since his commission into the Indian Air Force as an Aviation Meteorologist in 2007, he has actively served over varied terrains all across the country right from copiously wet and humid Assam, to the hot Norwester-prone plains of Punjab as well as the cold deserts of Leh, Laddakh frequented by Western Disturbances throughout the year. He is a meteorologist by heart and not just by profession. His hobbies include music, cooking and active participation in sports.

He is intelligent, talented and responsible person and helps others. He likes sports (Table tennis, Golf) and music. A man who is calm and hardworking. When other students wrote 10 pages journal report he wrote 100 pages.!!

Sqn Ldr Sarungbam Denny Singh
Aviation Meteorologist (IAF)
Guide : Dr. Satya Prakash Ojha, AOSG/SAC

Tropical Cyclone Intensity Prediction Over North Indian Ocean Using HWRF Model

The impact of atmosphere–ocean coupling on Tropical Cyclones (TC) and the irrefutable impact which the ocean response has on the Tropical Cyclone's intensity, after years of studies now, have been proved beyond doubt. This study aims at experimentally verifying the effect of ocean coupling on cyclone intensity forecast over the North Indian Ocean (NIO) using NCEP's Hurricane Weather Research and Forecasting (HWRF) model. The coupled model comprises of Weather Research and Forecasting (WRF) model as the atmospheric component, which is coupled with the Princeton Ocean Model (POM) as oceanic component. Experimental model runs were performed and differences between the coupled and the uncoupled forecasts were compared. In each of the cases, use of accurate and real-time sea surface temperature (obtained through data assimilation on the Levitus Climatology data) showed significant improvement in the prediction of TC intensity during intensification/decaying phases. The results show that dynamic atmosphere–ocean coupling has visible impact on tropical cyclone intensity prediction. Cases were studied of the tropical cyclones that formed over the NIO basins. Very significant improvements in the intensity prediction of these cyclones were observed due to the atmosphere-ocean coupling. However, no significant differences were observed in model predicted tracks from uncoupled and coupled runs (Fig. 1). Forecasted Maximum Sustained Winds (MSW) by coupled model matched very closely with observed values reported by JTWC, while uncoupled model, by far, over-estimated the MSW values by ~20 kt (Fig. 2). The results are really encouraging, to say the least, and much can be explored in terms of HWRF as an effective tool for prediction of tropical cyclones over NIO basins.

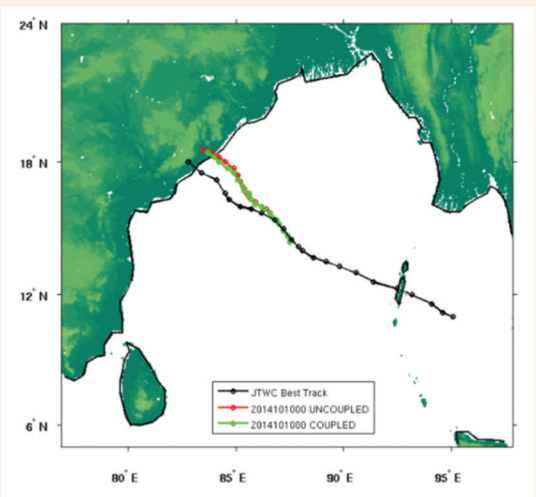

Figure 1: Forecasted tracks of cyclone "Hudhud" along with JTWC best track.

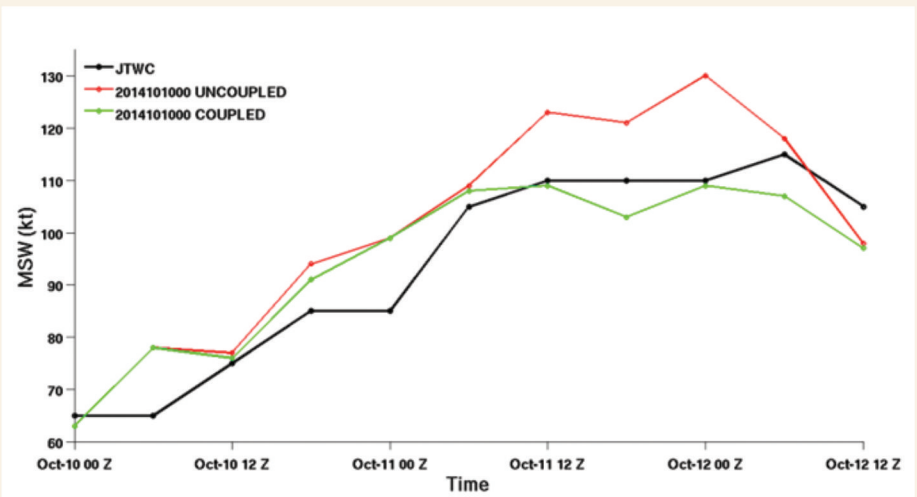

Figure 2: Time series of model predicted MSW of cyclone "Hudhud" along with JTWC best estimate values.

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Born on 9th December 1989 at a lovely place – Esik of Almaty Province, Kazakhstan. He joined the Kazakh National University named after Al-Farabi in 2008 and obtained his bachelors degree in Hydrometeorology in 2012. Further he obtained his masters degree in Meteorology in 2014. Since 2012 he has been working as engineer-forecaster at Almaty branch of RSE "Kazhydromet".

He is a handsome boy. A very cheerful, fun-loving and a bagful of energy guy. He is also very helpful and understanding. His motto is – Work Hard. Party Harder!! He can mimic any character in the world !

Mr. Abayev Nurlan Nusipbaevich

Weather forecaster

Guide: Dr. Sukanta Das, AOSG/SAC

Simulation study of the climate over Kazakhstan using Atmosphere Global Circulation Model (AGCM)

The climatic variability over Central Asian country Kazakhstan and its surrounding land-sea have been characterized through the simulation study using the global atmosphere general circulation model (AGCM). The wide variations in surface temperature across the country from west to east, influence of Siberia across the year along the north-east part of the country, presence of the Caspian Sea, the world's largest enclosed sea covering approximately 400000 km^2 situated in the south-west of Kazakhstan and strong influence of the drought prone sub-regions of the country make the climate simulation study quite challenging. The recent changes in the range of temperature and the rainfall pattern over the region have significantly high impact on the agricultural and socio-economic growth of the country. Further, the seasonal forecast over Kazakhstan using an AGCM demands the model credibility in successful reproduction of the past climate and its variability.

Community Atmosphere Model (CAM) developed by National Centre for Atmospheric Research (NCAR) has been used for the simulation study. 60 years of model climatology has been generated and analyzed using existing observed climatology of surface temperature, wind circulation, rainfall distribution over Kazakhstan. The observed climatology of surface temperature and precipitation is generated from different existing observations both satellite and in-situ by University of Delaware. The validation study also usage 50 years of in-situ observations of temperature and rainfall measured by 18 meteorological sub-stations situated over West Kazakhstan. The major objective of the present study is to investigate the model credentials in simulating the present climate over Kazakhstan. Further, the impact of sea surface temperature (SST) on the distribution of rainfall over the country has been investigated through the model sensitivity studies. A couple of CAM simulations each of 10 years viz. from 2004 to 2014 have been conducted using the climatological SST and the monthly observed SST as boundary conditions.

The model-derived climatology matches well with the observed climatology (Fig.1); however, overestimation in surface temperature in the order 3-5°K over South-West Kazakhstan during summer months can be seen. Fig. 2 shows the domain average surface temperature over the land-mass closely follow the observed climatology. Also, CAM simulated precipitation (Fig. 3) describes temporal and spatial distributions satisfactorily over the study region when compared with CMAP and University of Delaware derived climatology. Overall, the study provides a firsthand insight into the model creditability in capturing the climatic variability over Kazakhstan and its possibility to be used for seasonal forecast experiments in future.

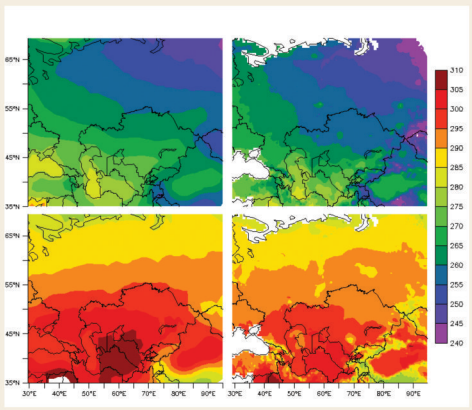

Fig.1 CAM climatology of surface temperature (left) compared with observation (right) during January & July

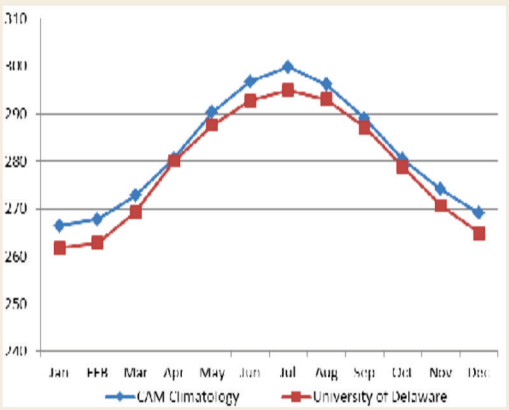

Fig. 2 Comparison of surface temperature of CAM with observation averaged over the landmass of Kazakhstan

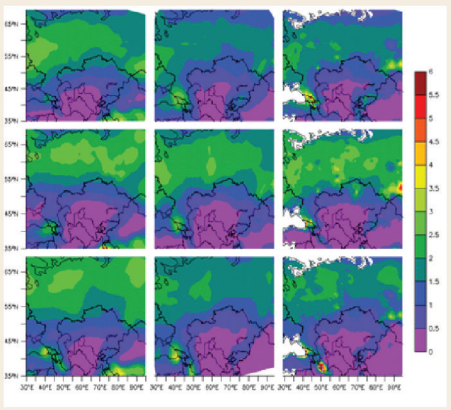

Fig.3 Monthly climatological precipitation generated by CAM (left) compared with CMAP derived observed climatology (central) and University of Delaware generated climatology (right) averaged for the months of May-June, July-August and September-October (top to bottom)

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Born on May 7th, 1984 in Pavlodar and living in the capital city of Kazakhstan, Astana. He graduated from the University of Economics KazPatreb Soyuz and obtained his bachelor's degree in Information System in 2006. Presently working as senior engineer in Republican State-owned Enterprise "Kazhydromet". His work consists of providing Weather Research Forecast (WRF) products. Fond of swimming, playing volleyball, surfing the internet and ofcourse, hanging out with his friends.

Most reserved person in the group! He likes programming. The only guy who wakes up in the morning and does jogging in the hostel campus.

Mr. Akhmet Sulemenov
Engineer Climatologist
Guide : Dr. Sasmita Chaurasia, AOSG/SAC

Detection of fog over Kazakhstan using Satellite data

A new fog detection technique using sounding data has been addressed over Kazakhstan. The fogs stability index (FSI) has been calculated using the temperature and humidity information at different levels of AIRS and IASI data. However, as there is no satellite data that gives wind at surface level the model wind of GFS and ECMWF has been used. The FSI gives an indication whether it is shallow, moderate or dense fog. Different threshold are use to categorized the fog and fog maps over Kazakhstan for December 2013 to January 2014 and December 2014 to January 2015. The results has been cross compared with INSAT-3D generated fog maps.

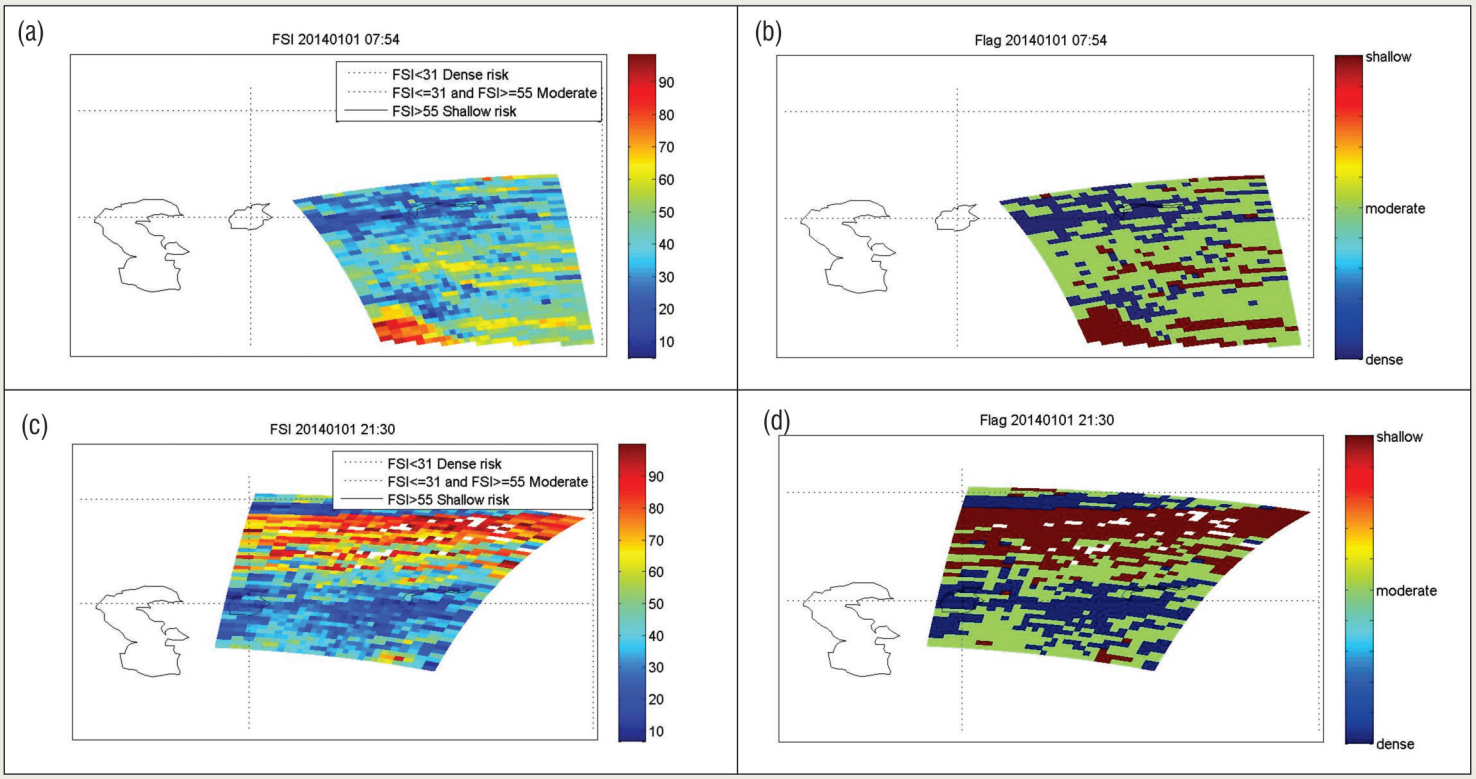

Figure 1. Fog Stability Index (FSI) maps over Kazakhstan (a &b) 01 January 2014, 0754UTC and (c & d) 01 January 2014, 2130 UTC.

Ms. Guldana Uatkhan kyzy
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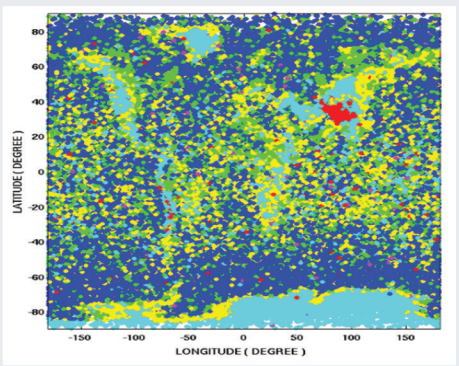
Born on 4th September 1989 in Jetisu of Kazakhstan and living in the capital city of Kazakhstan, Astana. She joined the Kazakh National University named AL-Farabi in 2007 and obtained her bachelor's degree in Hydrometeorology in 2011. She has been working as Engineer climatologist for Department of Meteorology RSOE “Kazhydomet”. Dancing and yoga are her hobbies. During her free time she likes to read books of the genres of psychology, self-development and modern prose, besides travelling and shopping of all kinds of sweets. She is interested in culture and traditions of different countries.

Strict for herself and others. Likes shopping, travelling and sightseeing. Her favourite word is “solnce ... which means my sun”. She is a photos freak. She puts her photos in the internet as fast as Sun's rays reach earth!!

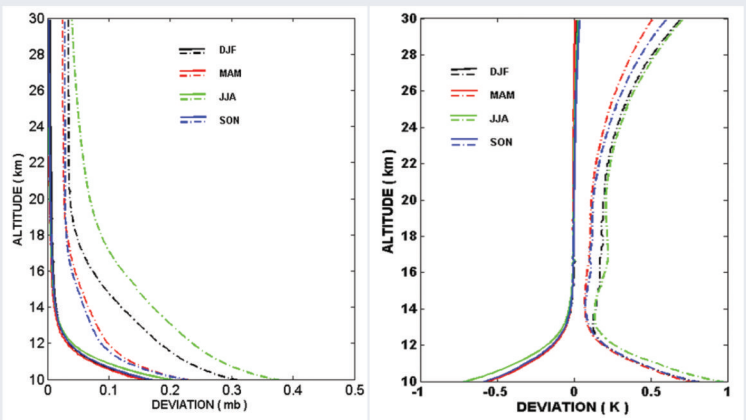
Ms. Guldana Uatkhan Kyzy
Engineer climatologist
Guide : Dr. Abhineet Shyam, AOSG/SAC

Morphological analyses of global tropopause using radio occultation data

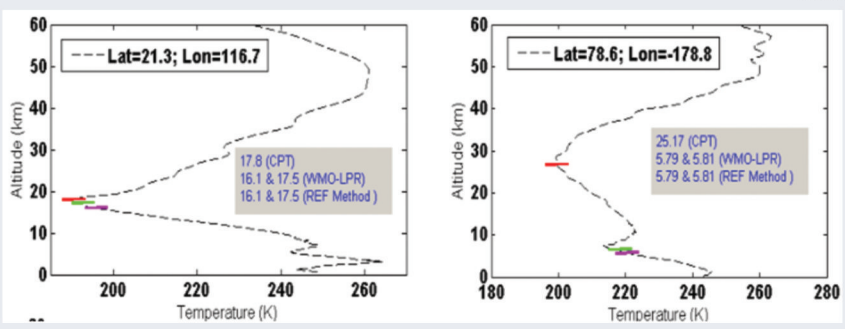
Morphology of the global tropopause, crucial for understanding tropospheric-stratospheric exchange and coupling of water vapor and trace gases, as also its indicative role for monitoring global change, is generated using COSMIC radio occultation data. Ideally, such studies require a long time-series of radio occultation data. However, in this short-term study with one year of dataset, the objective is to assess the feasibility of radio occultation data in detection and delineation of tropopause properties, such as tropopause sharpness and double tropopauses. COSMIC refractivity data for the year 2011 is inverted using the retrieval algorithm (Shyam et al., 2010) to derive atmospheric profiles of temperature and pressure. Statistical comparison of derived profiles with COSMIC operational products yields a mean difference of better than -0.5K and 0.2mb for temperature and pressure, respectively, in the upper troposphere and lower stratosphere (UTLS) region. The standard deviation is within 0.5K and 0.5mb, thus showing a good agreement with operational products. Tropopause parameters, in terms of tropopause- temperature, pressure, refractivity and sharpness, are determined based on detection of tropopause height using three different methods viz., cold point temperature, lapse rate of temperature (WMO method) and a newly developed refractivity-based method. The refractivity method compares exceedingly well with the WMO method, and both the methods demarcate anomalous tropopause cases in the cold point method, especially in the extra-tropical region. COSMIC-derived tropopause parameters are compared with those fromthe collocated radiosonde for the same period to measure the relative differences. Finally, the morphology of global tropopause properties are generated, assessed and analyzed in terms of zonal, meridional, annual-mean and seasonal characteristics and intra-annual variability.



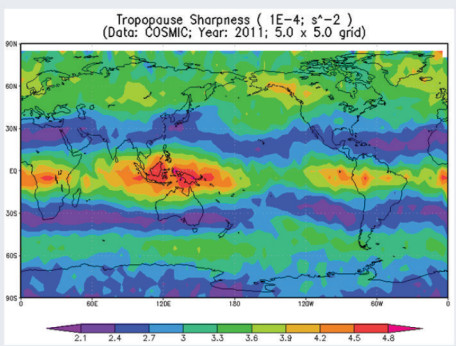
Spatial distribution of penetration depth show significant number of soundings below 0.5km (dark blue dots)



Seasonal bias (solid) and standard deviation (dashed) of retrieved temperature and pressure against COSMIC operational products for year 2011.



Cold point (red), first (green) and second (magenta) tropopause detected using the three methods; cold point tropopause; height anomaly seen in extra-tropical latitude (right figure)



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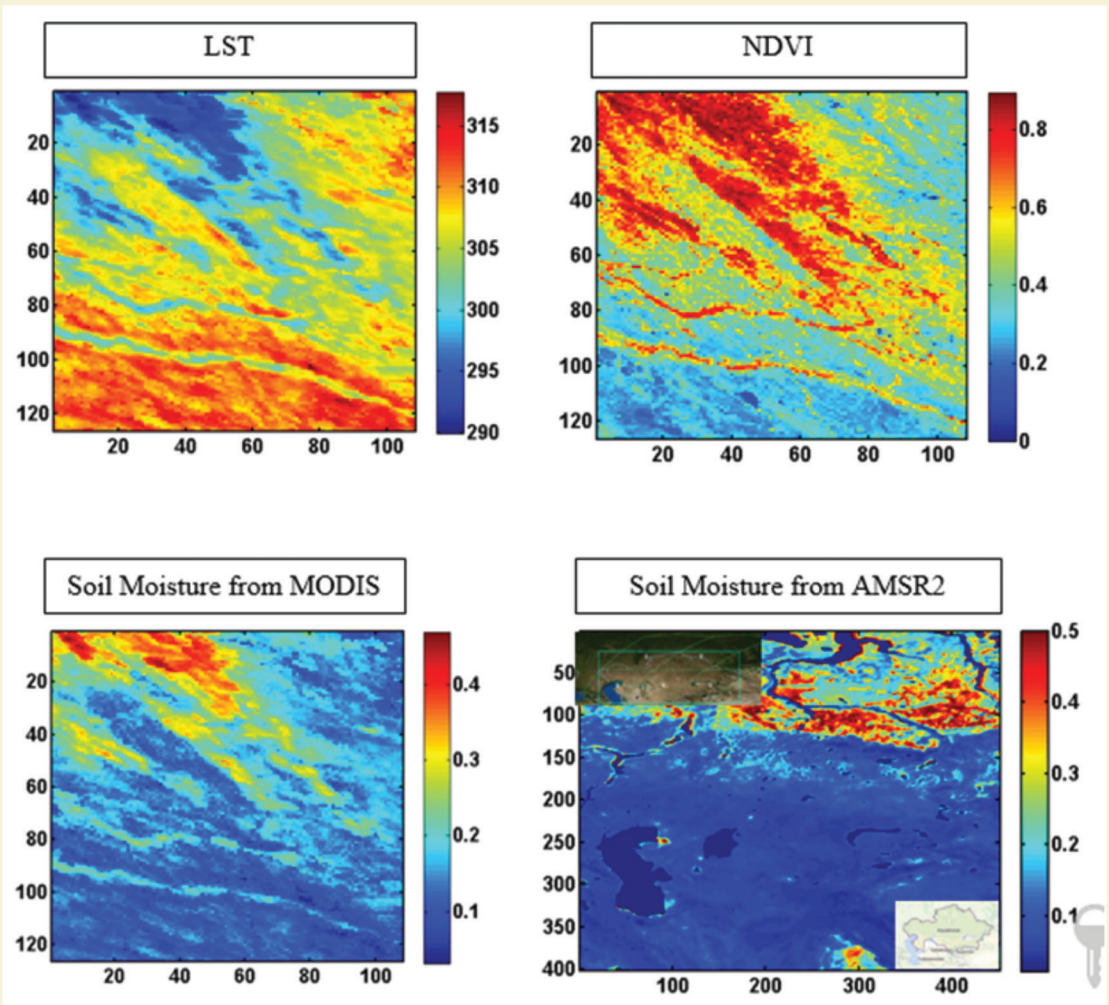
Born in Kyzylorda city, south-west of Kazakhstan. Presently staying at Astana, the capital of Kazakhastan. She graduated from Kazakh National University named after Al-Farabi in 2007 and obtained bachelor's degree in Meteorology. Since 2008, she has been working as a lead engineer in the Department of Agrometeorology RSE “Kazhydromet”.

Very calm and shy lady. She speaks very softly. A strict vegetarian, likes tropical fruits and vegatebles, especially water-melon, Papaya, Mango etc. An accomplished yoga master. During this course she organized yoga class for her groupmates.

Ms. Saliyeva Kamar
Engineer Agro meteorologist
Guide : Dr. Bimal Bhattacharya, CAD/ABHG/EPSA/SAC

Soil Moisture Estimation using Satellite Data Over Kazakhstan

Surface soil moisture is one of the important dynamic quantities that control land surface and hydrological processes in weather forecasting models. In addition, regular updation of large-area soil moisture status is essential to provide agro-meteorological advsiories to farmers for optimum agricultural management. Remote sensing observations in thermal and microwave regions of electromagnetic spectrum are increasingly being used to estimate large-area surface soil moisture. Given the availability of moderate resolution and hightemporal thermal remote sensing observations, soil wetness index (SWI) was estimated using traingular space of eight-day land surface temperature (LST) and normalized difference vegetation index (NDVI) from MODIS satellite over Northern part of Kazakhstan districts having large variation in vegetation cover. Volumetric surface soil moisture was estimated during dry-down period of 15 July to 15 August 2014 from wetness index using upper and lower limits of soil moisture. The cropped soil showed soil moisture range within 0.1 - 0.3 m^3m^{-3} having LST within 300 – 315 K and NDVI within 0.3 – 0.65. MODIS-based estimates were evaluated against microwave-based estimates and in situ measurements.



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Born in capital of Kyrgyzstan Bishkek in 1991. He graduated from public school No1 in 2009 and from Kyrgyz-Russian Slavic University in 2014. He has been working in department of glaciers, avalanches and highland lakes of Kyrgyz hydrometeorology agency under ministry of emergency situations since 2012. Playing football and reading are his hobbies.

The most intellectual person in the batch! Good at studies and grasps the subject test. He is nick named as “Little Einstein”. Very thorough in basic sciences. He likes to ask Smart questions. His favorite topic is speaking about mountains and avalanches. His favorite phrase is 'B-o-o-m' Mister “HOW? And “WHY?”.

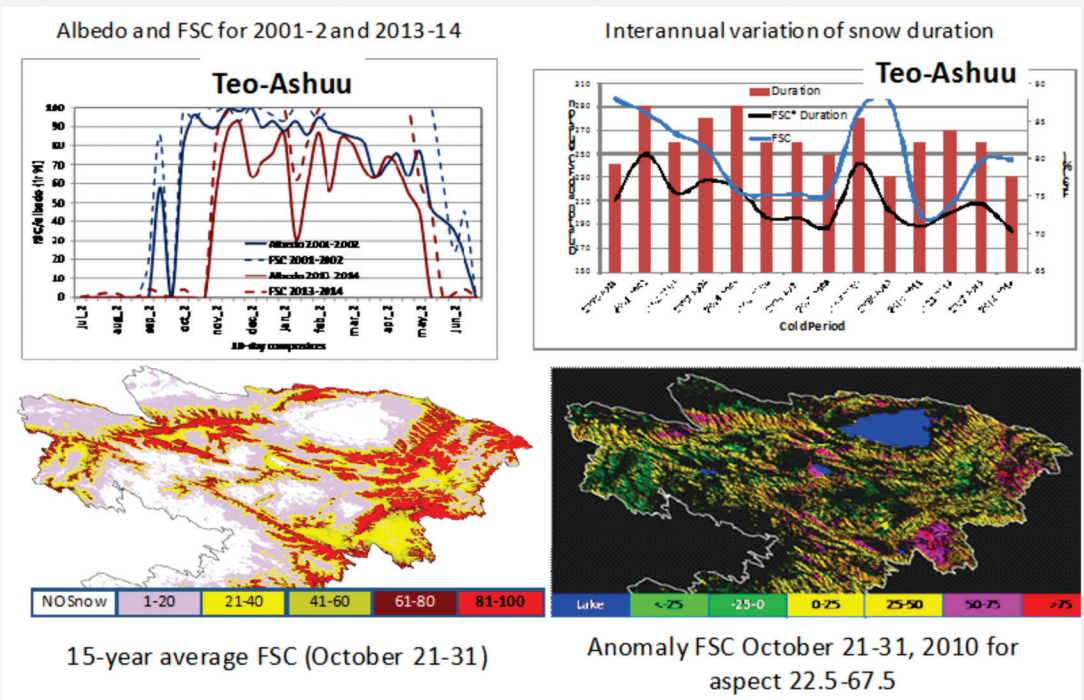
Mr. Rasul-Akhun Baikhadzhaev
Meteorologist
Guide : Dr. Sandip Oza, AOSG/SAC

Snow Cover Mapping and Monitoring in the Kyrgyzstan

Cryosphere is an important feature of the Kyrgyzstan landscape and during winter almost entire country is covered by snow and about 4% of the country permanently covered by glaciers. This is major source of the water resources in the country. Every year snow avalanches damage the national economies of the country mainly transport, communication and power line networks, as well as industrial projects in mountains. Hence understanding of the spatio-temporal distribution of snow in this region is critical and demands for the long-term mapping and monitoring. Remote sensing is the only viable tool for the continuous monitoring of the Kyrgyzstan's cryosphere. The present analysis demonstrates monitoring of snow cover over 15-year period (2000-2014) using MODIS snow products.

Daily 500m resolution products, available from National Snow and Ice Data Centre (NSIDC), were utilized to generate 10-day composite products of fractional snow cover (FSC) and albedo. Spatial and temporal filters were applied to minimize the problem of cloudy pixels. Time-series comprising 534 images (for FSC and albedo) were analysed to study the snow cover using MATLAB and ENVI-IDL tools.

Ninety meter resolution SRTM-DEM data were utilised to generate the slope and aspect images to analyse the snow distribution at various slope, aspect and elevation classes. Seasonal and inter-annual variations in snow area have been investigated. Anomalies from 15-year's average were instigated in details to understand the spatio-temporal variability in FSC and albedo over Kyrgyzstan. Surface meteorological data were utilised to understand the anomalies. Observed Snow duration at Teo-Ashuu station was minimum in 2009-10 and maximum in 2001-2002. Anomalies observed at various slope-aspect-elevation classes provides useful information for prediction of avalanches along with snow depth information that can be derived from passive microwave data, which can be taken up as future activity



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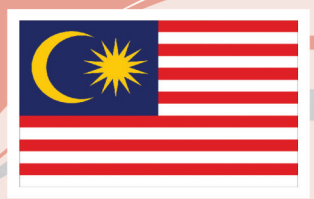
Born on 2nd July 1986 in Kuala Lumpur, Malaysia. He graduated from the University of Terengganu in 2008 with Bachelor's in Applied Science (Honours) Physics. He joined Malaysian Meteorological Department (METMalaysia) in 2010 as Meteorological officer. After completing the training for one year, he was assigned to regional forecast office at Penang International Airport which responsible in monitoring weather and providing meteorological services for civil aviation and also for public. He was also assigned to supervise Malaysian National Tsunami Early Warning System installed with in north-western part of peninsular Malaysia. His favorite past time is reading historical books, watching movies and enjoying good coffee.

He, the Malaysian hero likes to eat masala food. Very calm and friendly person. He does everything carefully and slowly. His favourite words are “HAH... ARE YOU KIDDING?”



Abstract

Mr. Syed Mohd Faiz Bin Syd Mahusin

Metrological Officer

Guide: Mr. Rishi Kumar Gangwar, AOSG/SAC

Validation of Saphir Larh with Radiosonde Observations Over Malaysia

Water vapour in the air, the humidity, plays an important part in global weather and climate. In order to describe the mechanisms driving the distribution of water vapour and clouds, long term observations with high temporal and spatial resolutions are required. The microwave sounder SAPHIR (Sondeur Atmosphérique du Profil d'Humidité Intertropical par Radiométrie) onboard Megha-Tropiques , launched in October 2011 is a six-channel instrument to measure radiation around 183.31 GHz for deriving profiles of atmospheric humidity. SAPHIR gives the vertical profile of layer averaged relative humidity (LARH) of six layers viz. 1000-850, 850-700, 700-550, 550-400, 400-250 and 250-100 hPa. The present project deals with the validation of SAPHIR derived LARH for above mentioned LARHs with RAOB observations over Malaysia for the period of July-December, 2014. To quantify the validation errors in SAPHIR LARH, bias and root mean-square-difference (RMSD) has been computed for all the six layers. The LARH profiles form SAPHIR have been collocated with RAOB LARH profiles with in 1 hour of time difference and 0.1 deg spatially. The RMSD for all the layers is found to be ~20% (figure 1), which is well with-in the mission requirements.

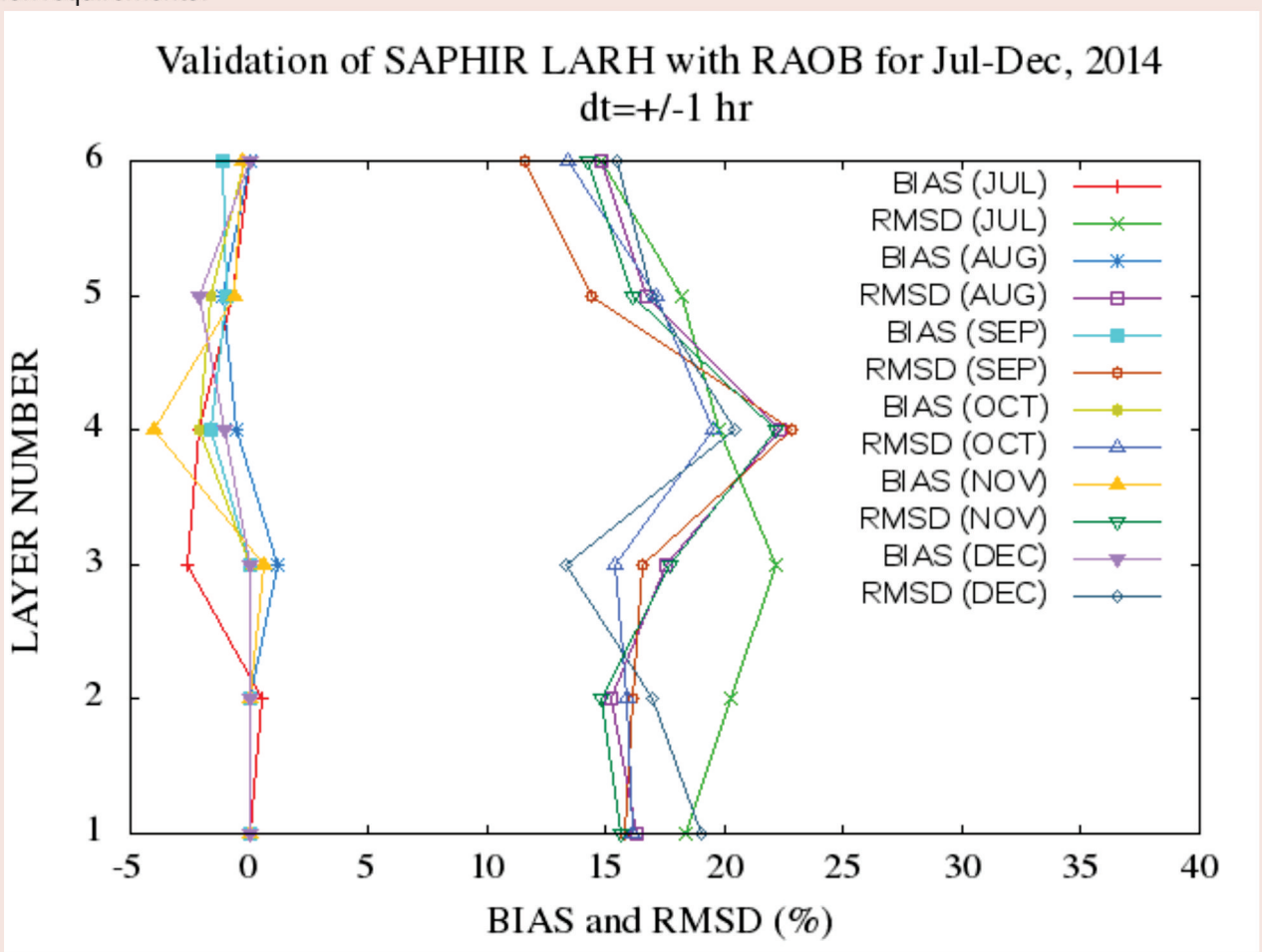


Figure (1) Validation result for SAPHIR LARH

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Born on 7th June in 1981 in UVS and presently living in the capital city of Ulaanbaatar, Mongolia. She obtained Bachelor of Science (Meteorology) during 1999-2003 and Master of Science (Meteorology) during 2003-2005; both from National university of Mongolia. She joined Aviation Meteorological Center since June 2003 as a forecaster.

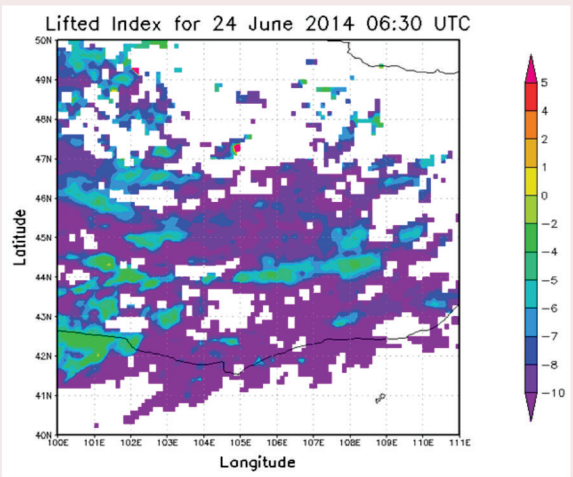
Never go with her to any shopping place, definitely she will be lost !!, Yes, She likes SHOPPING. Everyday she changes her bags. She has different bags for every occassion. She is always calm and shy. Likes jokes. Her favourite word is " many-many..."

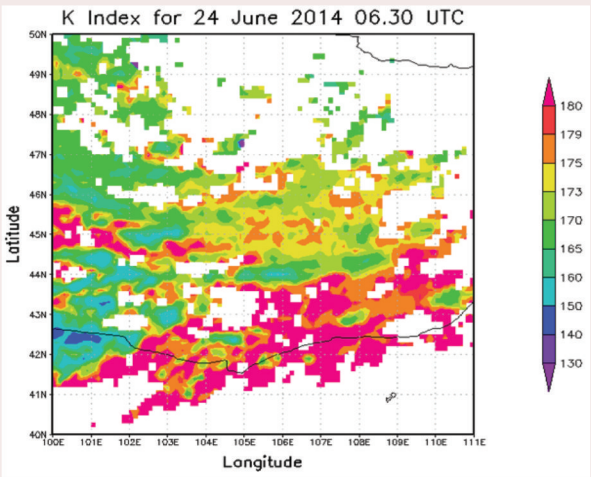
Ms.Battsetseg Buyantogtokh,
Senior Weather Forecaster
Guide : Mr.Danish Hussain, AOSG/SAC

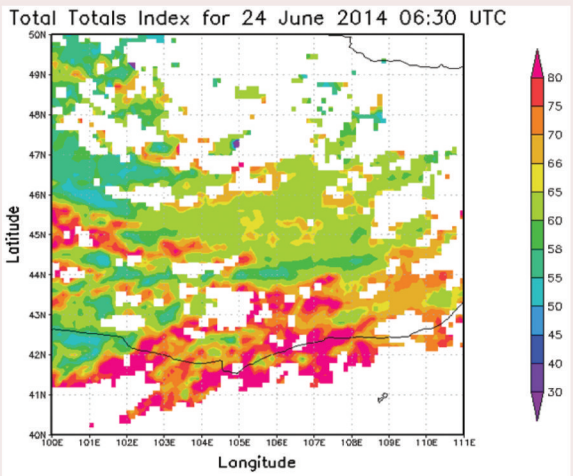
Analysis of Mesoscale Convective System using Satellite Data

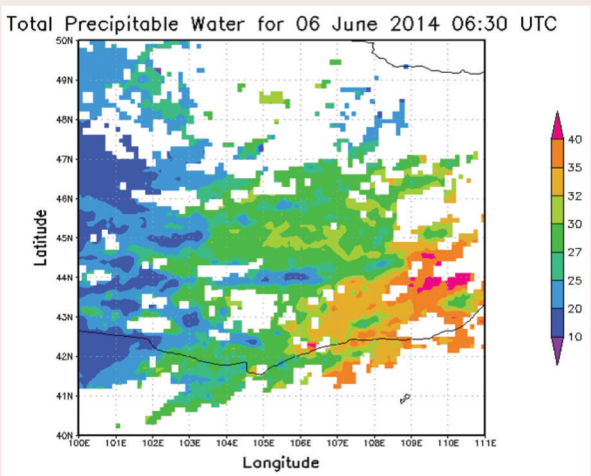
Forecasting of Mesoscale Convective Systems (MCSs) has two contrasting sides. On positive side, they produce a significant amount of rainfall for agriculture. On negative side, slowly moving and long lasting MCSs produce very heavy rain, thunderstorms, strong winds and often hail which causes a lot of damage to agricultural crops, property and aviation.

Mesoscale Convective Systems (MCSs) were studied to understand the precursor environment associated with these systems over Ulaanbaatar, Mongolia (latitude 47°N longitude 107°E) for the duration of two months (June and July of 2013 and 2014) using stability indices from satellite data. For this a number of MCSs were indentified and analyzed to understand their evolution. Different types of stability indices and some suitable dynamical parameters (from model reanalysis data) were selected based on the environmental conditions over the region of study. Threshold values of these stability indices were set for these systems which give a clear indication of convective development. These threshold values can be used for the development of MCS forecasting over the region of study.









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Born on 4th August 1982 in Dornod province Mongolia. She earned Bachelor of Science (Meteorology) during 1999-2003, and Master of Science during (2007-2010); both from National University of Mongolia. She is working as a forecaster for Center for Meteorology, Hydrology and Environment Monitoring in Dornod province, Mongolia since June 2003.

Tallest girl in the group. She speaks very fast. At first sight she looks strict, but you are wrong!! In fact she is like a small girl. She is a very good cook. She likes to dance traditional Mongolian dances.

Ms. Garamkhishig Gansuren
Weather forecaster
Guide : Dr.Atul Kumar Varma, AOSG/SAC

Rainfall Estimation Using Ssmis Scattering Index Over Mongolia

Accurate rainfall estimation is very important for many applications, such as water resource management for agriculture and power, and flood and drought monitoring.

The southern portion of Mongolia is taken up by the Gobi desert, while the northern and western portions are mountainous regions. The 85% of annual precipitation falls during warm season (from April to September), and out, which 50-60% falls during July and August. The accuarte estimation of precipitation is a challenging task.

The objective of this study is to evaluate the potential of satellite based rainfall estimates using Special Sensor Microwave Imager / Sounder (SSMIS) onboard DMSP F-17 satellite. The Tropical Rainfall Measurement Mission (TRMM) Multi-satellite Precipitation Analysis (TMPA) 3B43V7 product over Mongolian (latitude 42^0-50^0, longitude 90^0 -120^0) is used for inter-comparison. The conventional rain gauge observations for summer time (June, July and August) in 2014 are used for validation at the spatial scale of 0.25^o x0.25^o.

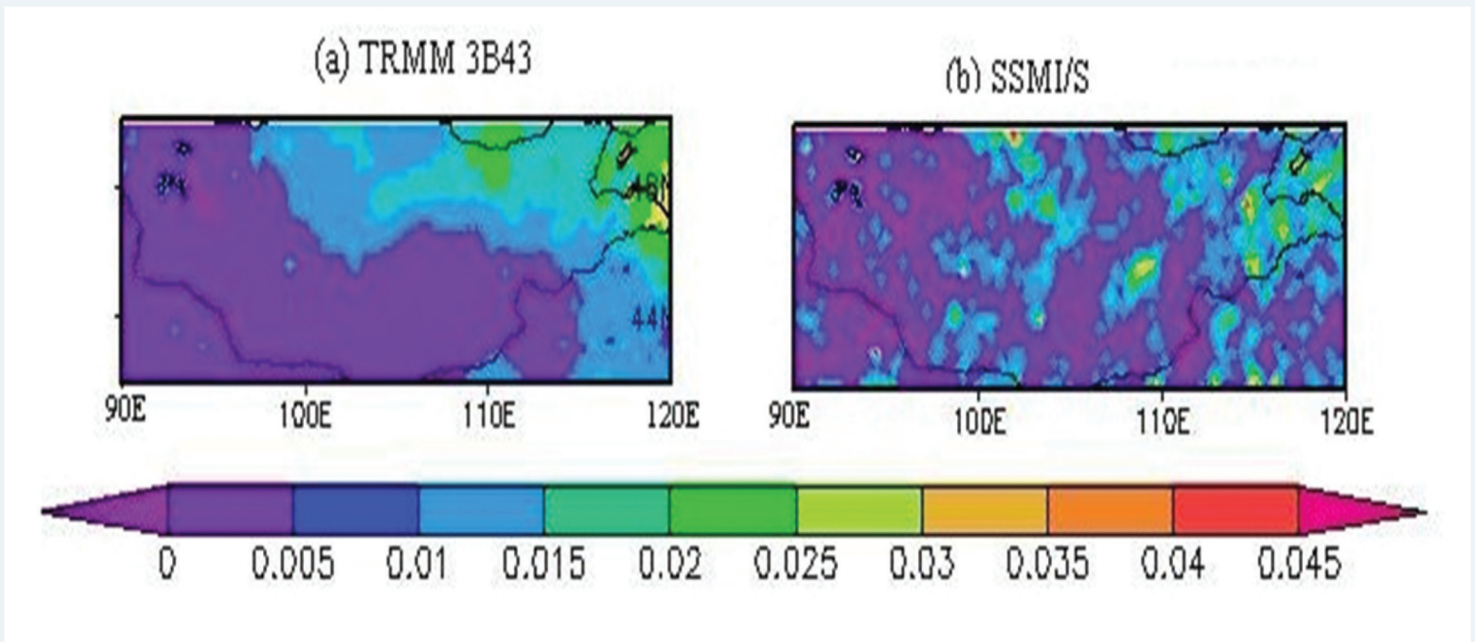

Fig. : Rainfall during July 2014 from (a) TRMM 3B43 and (b) SSMI/S.

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Born on 12th October 1981 in Bohmoron Uvs and lives in the capital city of Ulaanbaatar, Mongolia. She earned Bachelor of Science (Meteorology) during 1998-2002 and Master of Science (Meteorology) during 2002-2004; both from National University of Mongolia. She began her career as a researcher in INSTITUDE FOR MONGOL ALTAI STUDIES in June 2004. Presently she is working as a weather forecaster in INSTITUDE OF METEOROLOGY, HYDROLOGY AND ENVIRONMENT since November 2011.

At first sight this lady look like small and helpless!! but you are wrong….. This small lady has very strong power and character. She knows traditional Mongolian wrestling. Also she is a good singer, she loves singing Mongolian songs. She is the motherly figure of the course! Affectionate and strong!

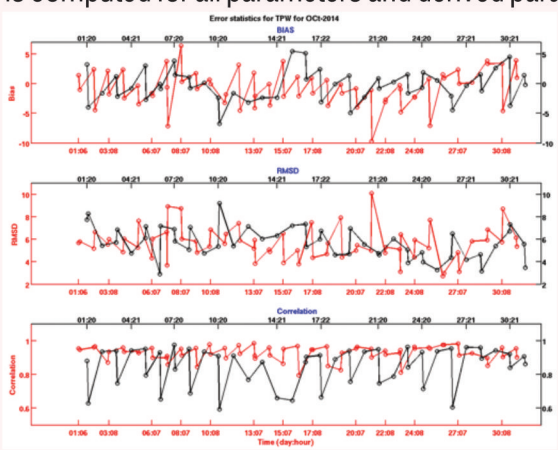
Ms. Oyunchimeg Otgon
Weather forecaster
Guide : Dr. Munn V. Shukla, AOSG/SAC

Validation and application of derived parameters from INSAT3D sounder data and MODIS data

INSAT-3D sounder provides invaluable information of atmospheric structure and high temporal resolution. The atmospheric structure available in terms of temperature, moisture and ozone profile helps in understanding and predicting atmospheric stability. The state of atmospheric stability is studied by using parameters such as Total Precipitable Water (TPW), Geo-Potential Height (GPH), Convective Available Potential Energy (CAPE), Convective Inhibition (CIN) and various stability indices such as Lifted Index (LI), K index (KI), Total Totals etc. Using atmospheric profiles from INSAT-3D sounder some of the very important derived parameters, TPW, LI and GPH are calculated to study atmospheric stability.

For any atmospheric products, it is essential to validate. In the present study, INSAT-3D sounder profiles and derived parameters are validated with MODIS derived parameters. MODIS is a multispectral imager on-board Aqua and Terra satellites and provides wide variety of land, ocean and atmospheric products. In this study Aqua atmospheric level-2 products are used for validation. Though MODIS products are available only twice a day over a given geographical region, however the high horizontal resolution and multispectral measurements help in providing more accurate cloud filtering therefore more accurate products. MODIS is not a sounder, therefore temperature and moisture profiles retrieved from MODIS are not accurate as products available from other hyper-spectral sounders such as IASI and AIRS, nevertheless the accuracy of derived parameters (used for studying atmospheric stability) is fairly good because for computation of derived parameters absolute accuracy of temperature and moisture profiles doesn't affect much, only the accuracy of vertical gradients in atmospheric profiles is more important.

In this study spatially and temporally collocated derived parameters from INSAT-3D sounder and MODIS are compared. Evidently, there will be more than one MODIS pixels corresponding to one collocated INSAT-3D pixels, because the nominal horizontal resolution of INSAT-3D sounder derived products at nadir is ~30 km whereas for MODIS derived parameter it is ~5km. Mean, median and mode and inverse square distance average of all collocated MODIS pixels corresponding to one INSAT-3D pixel is computed to find the best method for validation. Histogram analysis of mean, median, mode and inverse square weighted average suggest that except mode all other methods represent the same scenario so any one of them can be taken in validation exercise. For simplicity mean of all MODIS pixel is taken in final validation. Bias, RMSD and correlation is computed for all parameters and derived parameters used in validation exercise.



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Born on December 24th, 1989 in Kurgan-Tube of Khatlon region of Tajikistan and presently staying at Dushanbe, the capita of Tajikistan. He obtained his Masters degree in Meteorology from the Russian State Hydrometeorological University (RSHU) in 2014. He is lucky to join SATMET course the same year. He has been appointed as Engineer Forecaster in State Administration for Hydrometeorology in Tajikistan from July 01, 2014. His work consists of providing short-term weather forecasts for 1-3 days and for a week.

Very intelligent and real gentleman. He is a football fan. Loves to be the quiet and loves going to the gym. Always smiling, and is a perfect team man. He is also very sincere with his work, and keeps up the pace with the course.

Mr. Akhmedov Faridun Negmatulloevich
Engineer Forecaster
Guide : Dr. P.K. Thapliyal, AOSG/SAC

Assessment of INSAT-3D Sounder profiles using collocated products from AIRS, IASI, NCEP-Analysis and radiosonde for weather applications over Tajikistan

India launched the INSAT-3D satellite on 26th July 2013 to become the second country in the world after USA carrying onboard an atmospheric sounder in the geostationary orbit. INSAT-3D has six channels Imager and 18 infrared channels Sounder (plus a visible channel). INSAT-3D sounder provides a unique opportunity to have hourly measurement of temperature and moisture profiles over clear regions of India and a few adjoining countries and nearby oceanic regions. In addition to it, INSAT-3D is also providing total column ozone, total precipitable water, skin temperature and several stability indices. In the present study an attempt has been made to explore the potential of INSAT-3D Sounder products for weather applications over Tajikistan.

For the present study we have used INSAT-3D Sounder products for the period of July-December, 2014. For comparison purpose the best available satellite products from hyperspectral atmospheric sounders, e.g. AIRS onboard EOS-Aqua and IASI onboard MetOp satellites were obtained from the NASA and NOAA websites, respectively. The INSAT-3D profiles are also compared with the NCEP GFS analysis products. Since there are no upper air observations available over Tajikistan, the Radiosonde profiles were obtained from the nearby Kabul station for the validation purpose. INSAT-3D Sounder profiles are collocated within 0.5 deg lat/lon in space and one hour in time with IASI (ECT: 09:30 AM/PM), AIRS (ECT: 01:30 AM/PM), NCEP (0, 6, 12, 18 Z) and Radiosonde (0, 12 Z).

INSAT-3D retrieved profiles over two locations in Tajikistan have been validated/ compared with radiosonde, AIRS, IASI, and NCEP for vertical distribution of temperature and humidity profiles. In this study root-mean-square error (RMSE) and bias of retrieved profiles are computed using the collocated dataset from various sources. Profile over these locations will be analyzed in relation with the various weather events.

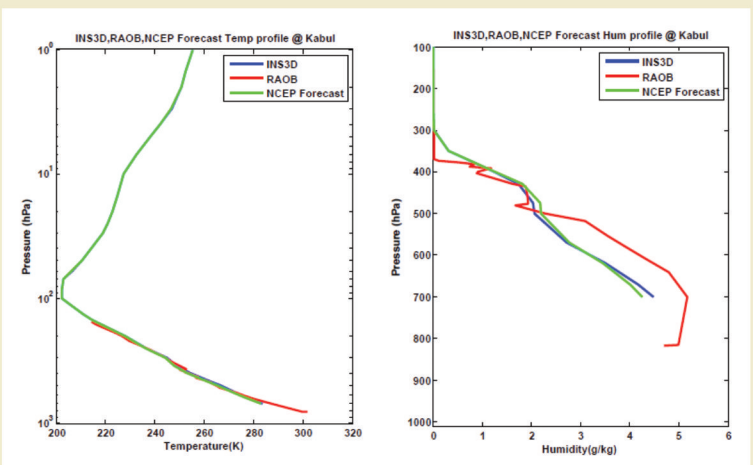

Figure (1) shows a sample INSAT-3D Sounder derived atmospheric profiles over Kabul and its comparison with the collocated radiosonde observation.

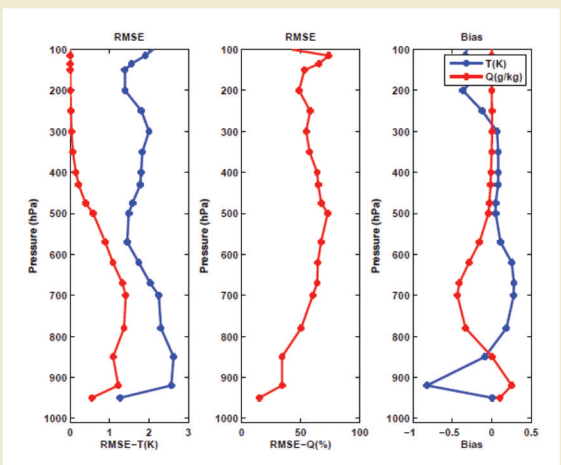

Figure (2) RMSE and Bias in INSAT 3D and IASI retrieved temperature and humidity profiles.

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Born on 15th November 1987 in Dushanbe, Tajikistan. He has completed his graduation with specialization in ecology in the year 2010 and Masters in Ecology in the year 2013; both from Tajik National University. He has been working in Climate change Centre, State organization for Hydrometeorology in Dushanbe city since 2011. He has attended one week's seminar training in The Energy Resources Institute (TERI) in New Delhi in May 2014.

He is an arm wrestler. Always confused with any food, whether the food is spicy or not. His favorite phrases are 'actually' and 'only '.The spicy man and his spicy stories continued throughout the nine months. But his innocence is there for all to be seen.

Mr. Faridun Sobirov
Climatologist
Guide: Dr. R.P. Singh, EHD/ABHG/EPSA/SAC

Variability of Green House Gases (CO_2, CH_4) over Republic of Tajikistan

Greenhouse gases trap heat (longwave radiation) in the atmosphere, keeping the Earth's surface warmer than it would be if they were not present. These gases are the fundamental cause of the greenhouse effect. Increases in the amount of greenhouse gases in the atmosphere enhance the greenhouse effect which is creating global warming and consequently climate change.

The concentration of atmospheric methane (CH_4) has more than doubled since pre-industrial times, and its radioactive forcing is estimated to be the second largest after carbon dioxide (CO2). Study was carried out to understand the variability of Green House Gases (CO_2, CH_4) over Tajikistan.

In this study Atmospheric Infrared Sounder (AIRS) and SCanning Imaging Absorption spectrometer for atmospheric cartography (SCIAMACHY) satellite data from 2003 to 2009 was analyzed to quantify the spatial and temporal variations in atmospheric CO_2 and CH_4 concentration over selected regions (Gogd province, Khatlon province, Khatlon province, Mountain Autonomous Badakhshon province) of Tajikistan.

Analysis indicated that the Badakhshon region has the highest CO_2 concentration about 406 ppm in January 2007 and Sogd region having the peak of CH_4 concentration about 1882.5 ppbv in May 2009. Inter annual analysis of CO_2 concentration over Takjikistan showed minimum value in 2009 (376 ppm), whereas maximum value was found in 2007 with 391 ppm. Interannual methane concentration over the country ranged from 1692 ppbv to 1902 ppbv with minimum concentration in 2003 and maximum in 2007.

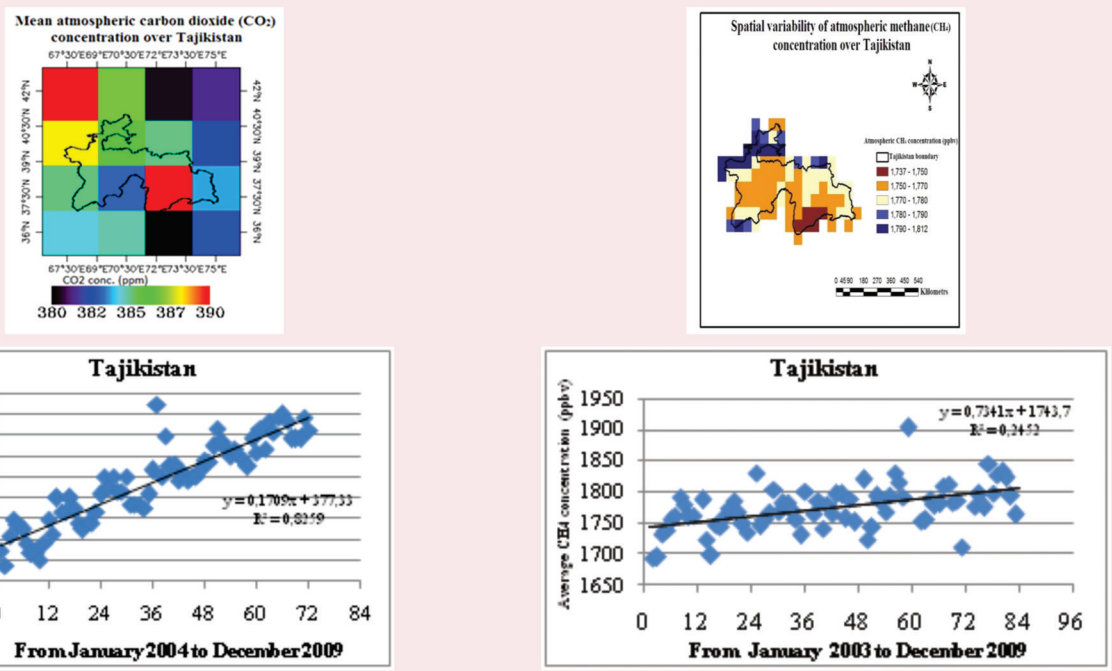

Fig. Spatial distribution of mean A) CO2, B) CH4, C) trend of Ave. CO2 conce, and D) trend of Ave. CH4 conce. between 2003-2009.

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Born on 15th August 1987 in Langson, Vietnam. She is a Bachelor of Oceanography (year 2009) from the Hanoi University of Science. She joined Vietnam Institute of Meteorologiy, Hydrology and Environment in 2009 as a researcher. Earlier, her main work was in air-ocean interaction research; especially, in simulating ocean processes. Presently she works as a manager of natural hazard risk management projects which are related to climate change. She is also pursuing her masters in climate change. Her favorite pastime is reading books, listening to music and travelling. She has travelled most of the province in her country.

Very smart interesting girl! To understand this little Vietnamese girl you need a very qualified translator and psychologist. She likes animals especially dogs. Her favourite word is “BUTnn...BUTnn BUTnn ....czczczczc.” . She likes to sing Vietnamese songs very loudly!!

Abstract

Ms. Doan Thi Thu Ha
Researcher
Guide: Dr Neeru Jaiswal, AOSG/SAC

Structural Analysis of Tropical Cyclone Using High Resolution Scatterometer Data

In the present study, the surface wind structure of tropical cyclones have been analysed to estimate the size of tropical cyclone using high resolution wind data (12.5 km) by Oceansat-2 Scatterometer (OSCAT). The size of tropical cyclone is an important parameter, which is required in various cyclone track prediction models. This estimation also helps in the assessment of affected region during landfall of cyclone.

The size of tropical cyclone has been estimated using two approaches based on vorticity and wind speed. In vorticity based approach, $1x10^{-5}$ s^{-1} contour of vorticity around the cyclone center has been identified and the azimuthally averaged radius has been taken as the size of tropical cyclone. In wind speed based approach, contour of 15 ms^{-1} wind speed around the cyclone center has been computed to estimate the size of tropical cyclone.

The above two approaches has been used validated by estimating the size of cyclones formed in the North Indian Ocean (10 cyclones) and West Pacific (80 cyclones) during 2010 – 2013. These results are compared to the size estimation based on radius of outermost closed isobar (ROCI) given by Joint Typhoon Warning Centre (JTWC). The correlation and mean absolute error (MAE) between size estimated in the present study (using vorticity based approach) and JTWC has been found as 0.7 and 37.12 km, respectively.

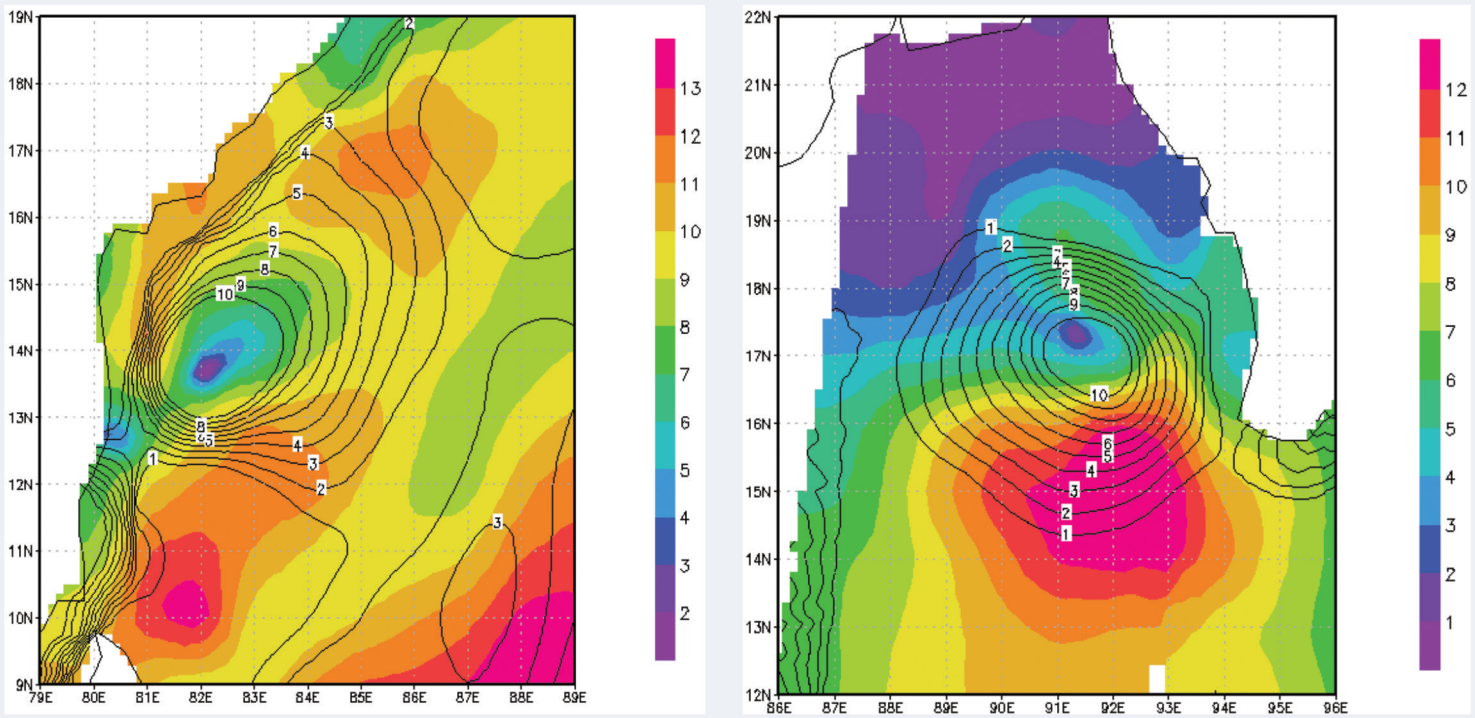


Figure: Plot of vorticity contour (10^{-5} s^{-1}) overlaid on the windspeed (m/s) for cyclone (a) GIRI at 05UTC 21 OCT 2010 and (b) LAILA at 17 UTC 18 May 2010.

Educational and Cultural Exposure

Educational and Cultural Exposure

Impression of Participants

It was a matter of pride and professional accomplishment for each one of us, to get chosen from our respective orgnisations for undergoing the internationally acclaimed CSSTEAP's PG diploma course in Satellite Meteorology and Global Climate (SATMET-9), being conducted from 01 Aug 2014 to 30 Apr 2015 at Space Applications Center (SAC), Ahmedabad, India. The excitement offered by the course was twofold, one at the prospect of exposure to cutting edge technology in the field of Satellite Meteorology and other for providing an opportunity to explore India, a nation of more than one billion population with rich history, cultural heritage and an epitome of Unity in Diversity.

The course started on a positive note as each of the participants were received from Airport/ Railway station in a meticulously coordinated way, overcoming administrative hassles and language barriers to put us at ease. Fully furnished single room accommodation with a kitchenette was earmarked for each participant in a systematic and thoughtful manner adhering to principles of comfort, communication and personal security at Bopal hostel, an architectural beauty in its own right. Personal facilities television and English news papers, communal facilities such as ever green lawns, beautiful flower gardens, common dining hall, washing machines, transport for purchases and Internet etc. are not only satisfactory but also have enhanced the quality of life.

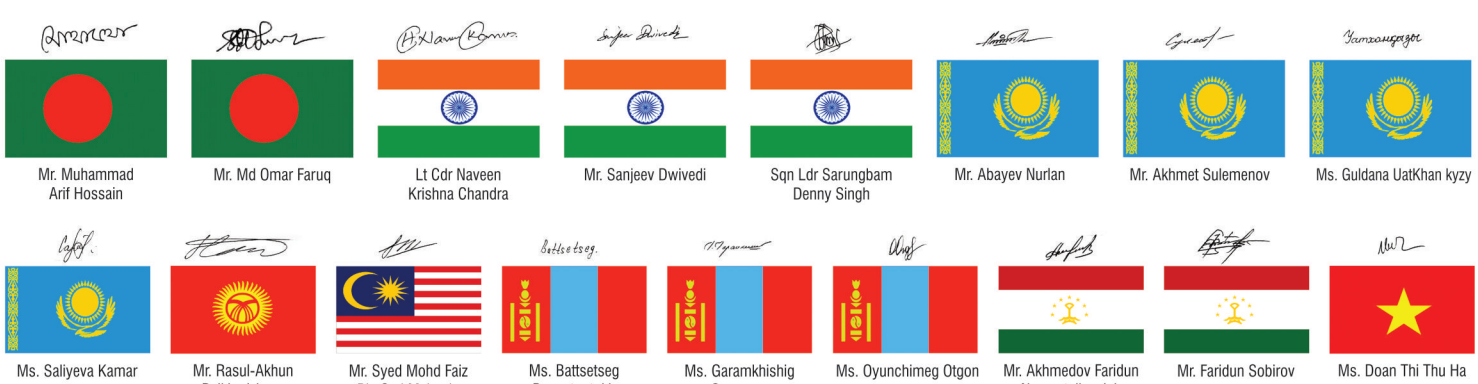
Coming to the brass-tacks of academics, the first formal interaction, laying foundation for the bonding between all 17 participants from 08 different countries of the course, took place in a class room which was equipped with centralized air conditioning, spacious cushion seating, white board, computer, projection system and audio visual recording. This was the place central to all our activities such as classes, presentations, evaluations, examinations etc. and our diametrically opposite emotions such as tension - relaxation, alertness-sleeping, remembering – forgetting, happiness- regret and enthusiasm – indifference etc. Soon, inaugural function was conducted which paved way for the Director SAC, Course Director, Course Coordinator and other eminent scientists to interact with the participants. Post inauguration, combined classes with 12 participants of Space Sciences Course, a parallel nine month course, for a week helped in expanding our reach and forging new friendships which enhanced share, care and fun quotient to overcome anguish and homesickness during our stay at hostel.

The long course was divided into three modules of three months each; the first module was easily the dearest to many participants as it enhanced our knowledge in basics of Meteorology, Oceanography, Asian Monsoon and basics of Satellite Remote Sensing etc. The second module is the core of this course dealing with Geophysical Parameter Retrieval and its application and Global Climate. The ongoing third module is the project work with each participant having been assigned a topic and an eminent scientist as Guide. The quality of instructors is as best as anyone can hope for as most of them are none other than the scientists who are responsible for the success story of Indian Space programme. And a few other instructors are drawn from prestigious institutes, Universities of India and abroad. It seemed time had wings and we are already staring at the culmination of the nine month course. This lapse in time was solely due to intensely packed academic activity planned by the course director in terms of weekly training programmes, presentations, tutorials, midterm tests, final exams, practical test and exams and journal writing etc.

All afternoons are occupied with practical sessions, guided mostly by the same faculty that taught theory so as to enable the students to physically do and gain hands on experience. A well maintained computer lab facility with a computer for each participant and stand alone internet connectivity.

We are thankful to the course director and his team for touching our hearts individually with gestures such as greeting on our birthdays through cards containing wishes of each participant, mixing with us, laughing with us and yet imparting valuable lessons not only academically but for life. The Course Coordinator is specially thanked for her tireless enthusiasm, to expose the participants to all prominent/ tourist places of Ahmadabad and also giving us the taste of celebration of all major Indian festivals, beyond the call of her normal duty. Even though, the scientific tour to north India got cancelled due to reasons beyond our control, the course director accomplished a memorable short trip to Mount Abu, Rajasthan which greatly revived the sagging spirits after arduous academic session that ended with grueling exams of first module. The cultural and scientific tours to south India went off as per the promulgated schedule and was overjoyed to visit satellite launch station, SHAR, Andhra University, Visakhapatnam and Real Time Tsunami Warning Centre, Hyderabad during February 2015.

As we bid adieu, we express our sincere gratitude to the Director CSSTEAP, Director SAC, Course Director SATMET IX, Course Coordinator, guides of all participants and the entire staff of SAC, Bopal campus for their cooperation, valuable help, encouragement and motivation during our training and stay in Ahmadabad. Last but not least, we are thankful to UN for honouring us to participate in this course and gratefully acknowledge the role of CSSTEAP, SAC in conducting it.



Mr. Muhammad Arif Hossain | Mr. Md Omar Faruq | Lt Cdr Naveen Krishna Chandra | Mr. Sanjeev Dwivedi | Sqn Ldr Sarungbam Denny Singh | Mr. Abayev Nurlan | Mr. Akhmet Sulemenov | Ms. Guldana UatKhan kyzy

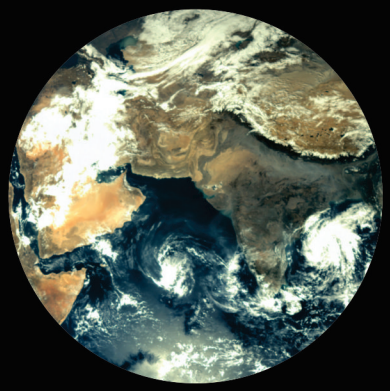
Ms. Saliyeva Kamar | Mr. Rasul-Akhun Baikhadzhaev | Mr. Syed Mohd Faiz Bin Syd Mahusin | Ms. Battsetseg Buyantogtokh | Ms. Garamkhishig Gansuren | Ms. Oyunchimeg Otgon | Mr. Akhmedov Faridun Negmatulloevich | Mr. Faridun Sobirov | Ms. Doan Thi Thu Ha

Centre for Space Science and Technology Education in Asia and the Pacific
SATMET - 9 (2014 - 2015)
Conducted at
Space Applications Centre, Ahmedabad

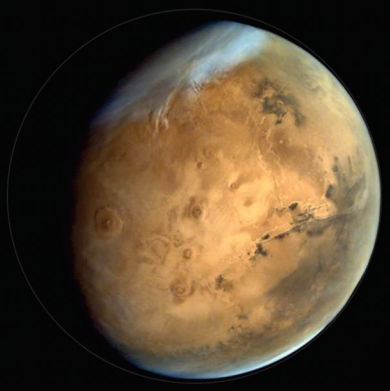
Sitting : Dr. B Simon, Shri Tapan Misra, Ms. Yogini V. Vanikar
(L to R)

Standing : Mr. Syed Modh Faiz Bin Syd Mahusin (Malaysia), Mr. Faridun Sobirov (Tajikistan), Mr. Akhmet Sulemenov (Kazakhstan)
(L to R) Ms. Guldana Uatkhan Kyzy (Kazakhstan), Mr. Muhammad Arif Hossain (BangladEsh), Ms. Doan Thi Thu Ha(Vietnam),
Mr. Rasul-Akhun Baikhadzhaev (kyrgyzstan), Sqn. Ldr. Sarungbam Denny Singh (india), Ms. Battsetseg Buyantogtokh (Mongolia),
Mr. Sanjeev Dwivedi (India), Mr. Abayev Nurlan (Kazakhstan), Ms. Oyunchimeg Otgon (Mongolia), Ms. Saliyeva Kumar (Kazakhstan),
Ms. Garamkhishig Gansuren (Mongolia), Lt. Cdr. Chandra Naveen Krishna (India), Mr. Md Omar Faruq (Bangladesh),
Mr. Akhmedov Faridun Negmatulloevich (Tajikistan)

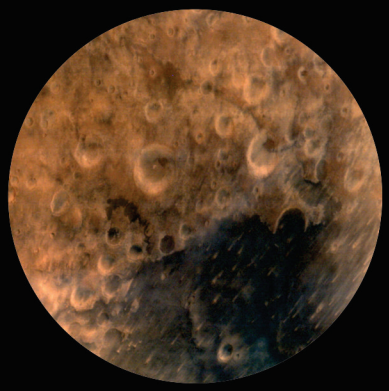
Images captured by Mars Colour Camera onboard Indian Mars Orbiter Mission (MOM)



EARTH
Nov 2013



MARS
Oct 2014



MARS
Nov 2014

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