CSSTEAP Newsletter

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

(CSSTEAP)

(Affiliated to the United Nations)

on a mission of capacity building, the initiative of the United nations, for Asia and the Pacific Region in Space Science and Technologym through Excellence in Education, Training and Research.

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Director, CSSTEAP, India

Governing Board Members and Special Invitees during 22nd Governing Board Meeting at Bengaluru on November 15, 2017

CONTENTS

Director's Message

The Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP) has been contributing significantly in empowering scientists and engineers in Asia Pacific countries in the frontier areas of Space Science and Technology and their Applications since its inception in 1995. In particular, its contributions have been focused on Post Graduate (PG) Courses in Remote Sensing and Geographic Information Systems, Satellite Communications & Global Positioning Systems, Satellite Meteorology & Global Climate, Space & Atmospheric Science and Global Navigation Satellite System, which are well recognized by UNOOSA as potential subjects for societal benefit applications. The Centre also conducts short courses on different themes of Remote Sensing and GIS applications, Small Satellite Missions and Navigation and Satellite Positioning system on regular basis. The Centre also organizes short courses and awareness programmes from time to time based on the request of user departments.

During the Year 2017, the Centre has conducted three PG courses and five short courses in which a total of 206 participants from 21 different countries have been benefitted. Presently, three PG courses are under progress having 55 participants. Till date the Centre has conducted 55 PG Diploma courses, 22 in Remote Sensing & Geographic Information System (RS & GIS), 11 in Satellite Communications (SATCOM), 10 in Satellite Meteorology & Global Climate (SATMET), 10 in Space & Atmospheric Science (SAS) and 02in Global Navigation Satellite Systems. In addition to PG Diploma course, 53 short courses have also been successfully conducted by the centre. These programmes have benefitted 1958 participants (916 under PG courses and 1042 under Short Courses) from 55 countries (36 countries in the Asia-Pacific region and 19 countries from outside Asia-Pacific region). Till date 155 PG students (74 in RS & GIS; 41 in SATCOM; 19 in SATMET and 21 in SAS) from 16 different countries have been awarded M.Tech. degree. Two alumni meets were successfully conducted during 2017 in Yangon, Mayamar and Kathmandu, Nepal. CSSTEAP has also contributed significantly in various UN initiatives, by participating in its meetings and providing training support.

As the main purpose of the courses is to empower the participants in respective disciplines, it is important that at the end of the 9-month long program, participants should have hands-on experience to apply the methods learnt in the class rooms.I am happy to note that the course participants of PG courses have taken up challenge to carry out a pilot project as part of the course curriculum. This certainly builds up confidence among participants to apply the methods studied to undertake future projects in their home country for their national development. This Newsletter provides an overview of the various activities conducted by CSSTEAP during 2017, including the summary of pilot projects carried out by PG course participants.

Dr. A. Senthil Kumar
Director

About **CSSTEAP**

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 December 11, 1990, the United Nations General Assembly (UN-GA) endorsed the recommendation of the Committee on the Peaceful Uses of Outer Space (COPUOS) to establish Regional Centres for Space Science and Technology in developing countries. Under the auspices of the United Nations, through its Office for Outer Space Affairs (UN-OOSA), six Regional Centres for Space Science and Technology Education have been established in the regions that correspond to the United Nations Economic Commissions for Asia and the Pacific (India and China), Africa (Morocco, Nigeria) and Latin America and the Caribbean (with offices in Brazil and Mexico) and Jordan for the West Asia region. The Centres are affiliated to the United Nations through UN-OOSA. Centre for Space Science & Technology Education in Asia and the Pacific (CSSTEAP) is the first Centre and was established on November 1, 1995 in India and has been Centre for Space Science and Technology Education in Asia and the Pacific imparting education/training in the areas of RS&GIS, Satellite Communications, 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 a 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 a 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.

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 UNAgencies 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:

1) Remote Sensing and Geographic Information Systems (RS & GIS),
2) Satellite Communication (SATCOM),
3) Satellite Meteorology and Global Climate (SATMET)
4) Space and Atmospheric Science (SAS), and
5) Global Navigation Satellite Systems (GNSS)

Apart from these, Centre conducts short courses on different themes of Remote Sensing and GIS, Small Satellite Missions and Navigation and Satellite Positioning system on regular basis. The Centre also organizes workshops & awareness programmes from time to time. Till date the Centre has conducted 55 PG courses Diploma courses, 22 in Remote Sensing & Geographic Information System (RS & GIS), 11 in Satellite Communications (SATCOM), 10 in Satellite Meteorology & Global Climate (SATMET), 10 in Space & Atmospheric Science (SAS) and 02in Global Navigation Satellite Systems. In addition to PG Diploma course, 53 short courses have also been successfully conducted by the centre. These programmes have benefitted 1958 participants (916 under PG courses and 1042 under Short Courses) from 55 countries (36 countries in the Asia-Pacific region and 19 countries from outside Asia-Pacific region). Till date 155 PG students (74 in RS & GIS; 41 in SATCOM; 19 in SATMET and 21 in SAS) from 16 different countries have been awarded M.Tech. degree.

Highlights

PG COURSES COMPLETED

RS & GIS: 21st PG course in RS & GIS at IIRS, Dehradun during July 1, 2016- March 31, 2017
(19 participants from 11 countries)

SATMET: 10th Satellite Meteorology & Global Climate at SAC, Ahmedabad during August 1, 2016 – April 30, 2017
(13 participants from 7 countries)

SAS: 10th Space and Atmospheric Sciences at PRL, Ahmedabad during August 1, 2016 – April 30, 2017
(12 participants from 02 countries)

PG COURSES ONGOING

RS & GIS: 22nd RS & GIS at IIRS, Dehradun during July 1, 2017- March 31, 2018
(22 participants from 12 countries

SATCOM: 11th PG course in Satellite Communications at SAC, Ahmedabad during August 1, 2017 – April 30, 2018
(21 participants from 9 countries)

GNSS: 2nd PG course in Global Navigation Satellite Systems at SAC, Ahmedabad during August 1, 2017 – April 30, 2018
(12 participants from 5 countries)

SHORT COURSES COMPLETED

Disaster Management Course in Myanmar Yangon, during March 28 - April 2, 2017 on 'Post Disaster (Earthquake) Rapid Damage Assessment' (44 Participants)

LIDAR Course Lidar Remote Sensing and its Applications in May 15-26, 2017 (21 participants from 09 countries)

UAV Course UAV Remote Sensing and its Application in June 12-23, 2017 (21 participants from 09 countries)

NWP Course Weather Forecasting using Numerical Weather Prediction Models at ISRO, Ahmedabad in July 3-14 2017 (25 participants from 11 countries)

6th Small Satellite Mission Course
Nov. 20 to Dec. 01, 2017 at IIRS
(40 participants from 15 countries)

21ST POST GRADUATE COURSE ON REMOTE SENSING & GEOGRAPHIC INFORMATION SYSTEM (RS & GIS)

The 21st Post Graduate Course on Remote Sensing and Geographic Information System of CSSTEAP commenced on July 1, 2016. A total of 20 participants from 11 countries of Asia and the Pacific Region have joined the course. Of the 20 participants, 3 each were from Kazakhstan and Sri Lanka, 2 each from Mongolia, India, Nepal, Uzbekistan and Myanmar and one candidate each from Fiji, Tajikistan, Kyrgyzstan and Thailand.

The course had been designed to help the participants at learning and skill development in geospatial technologies, as well as their applications in monitoring and conservation of the natural resources, tackling the challenges of climate change, natural disaster and their mitigation. The participants were from varied backgrounds like Hydrology, watershed management, Ecology, Meteorology, Urban and Regional planning, Geoinformatics, Surveying, cartography and disaster response.

The PG diploma course of 9 months duration consists of 2 semesters, spread in modules. The successful completion of 9 months training leads to award of PG Diploma. The successful candidates subject to qualifying for admission requirements of Andhra University, need to carry out a dissertation research work of one year in their home country which will lead to the award of M.Tech. Degree by Andhra University after its successful completion. The course structure is based on UN Curricula of UN-OOSA, with minor modifications as suggested by the International Advisory Committee and internal Board of Studies (BOS) committee.

The course started with an 'Induction week' where the participants were exposed to geographic perspective of India,

social systems, customs and festivals of India, overview of space science, technology and applications, etc. Semester 1 consisted of Module-1A and Module-1B. Module-1A covered basically the fundamentals of RS&GIS, including hands one exercises. The participants had several field excursions for ground truth collection and for interpretation and analysis of satellite data. Module-1B of Semester-I, of one month duration was on recent trends and advances in RS & GIS and environmental analysis & management including climate change.

In semester-II, the course participants choose one of the eight electives i.e. Agriculture & soils, Forestry & Ecology, Geosciences & geo-hazards, Marine & Atmospheric Science, Water Resources, Urban & regional planning, Satellite image analysis & photogrammetry and Geo-informatics. Based on their academic qualification, technical requirement of their parent organization and their professional experience, 5 participants each had opted Geoinformatics and Satellite image analysis & photogrammetry; 3 each for Urban & Regional Planning and Water Resources; 2 for Forestry & Ecology, two for Marine & Atmospheric Science. Again considering their interest they were assisted to choose specific topics in Module III- i.e. Pilot project.

The core components of course syllabus were covered by the faculty of IIRS and additional lectures by guest faculty on specialized topics was also arranged for the academic benefit of the course participants. The subject experts were invited from various Indian Organizations such as India Meteorological Department (IMD); Wildlife Institute of India, Dehradun, Indian Institute of Technology (IIT), Roorkee, National Remote Sensing Centre (NRSC), Hyderabad; Aryabhatta Research Institute of Observational Research (ARIES), Nainital; Space Applications Centre (SAC), Ahmedabad, Andhra University, Visakhapatnam etc. to deliver specialized lectures.

Valedictory function of 21st Post Graduate Course on Remote Sensing & Geographic Information System (RS & GIS)

Lecture notes in the form of printed books and supplementary reading materials were distributed well in advance to all the course participants to help easy assimilation of the subject in the class and also for future reading. Academic performance of the course participants was evaluated in each semester through periodic internal and external examinations in the form of written and practical examinations; class test, tutorials, seminar etc.

The pilot project of 3 months has been designed to help the participants to apply the knowledge which they have gained to carry out a project work on their own. Good quality project work has been carried out by the participants which have been evaluated by a panel of experts. Some of the notable areas of the pilot project carried out were: 3D Close Range Photogrammetry, Ecosystem services Assessment, Space based solutions for extreme rainfall events, Seasonal Variation of Chlorophyll-a with Suspended Sediments Concentration, Polarimetric and Interferometric Modelling For Vegetation Height Estimation, Impact of Climate Change on Runoff Response, Evaluation of Open Spatial Data for Topographic Mapping and Analysis of Open Green Spaces to name a few.

The participants of the course also participated in the ISRS-ISG National Seminar in December 2016 and user Interaction Meet during February 2017 at IIRS Dehradun. Technical and educational visits to Andhra University, Visakhapatnam and National Remote Sensing Centre, Hyderabad were undertaken during October 2016. The participants had opportunity to visit the Integrated Multi-mission Ground Segment for Earth Observation Satellites (IMGEOS) and watched the real time acquisition of EO data at Shadnagar, Hyderabad. At Andhra University, the educational records of all participants were scrutinized for assessing their M.Tech eligibility. Here the participants also attended lectures on specialized topics on environmental analysis & management, marine, weather forecasting, etc. On the social front, the participants had glimpses of Indian festivities by their active participation in various festivals such as Dussehra, Diwali, Id-ul-Fitr, Christmas, New Year, Holi, etc.

The Chief Guest awarded CSSTEAP Excellence medals along with merit certificates to the meritorious students. Six participants passed with Distinction, ten in First class and three participants passed as Pass grade.

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10TH POST GRADUATE COURSE IN SATELLITE METEOROLOGY AND GLOBAL CLIMATE

The tenth Post Graduate Courses on Satellite Meteorology and Global Climate was conducted at Space Applications Centre (Bopal Campus), Ahmedabad during August 1, 2016 to April 30, 2017. Thirteen participants representing seven countries of the Asia Pacific region have attended this course, viz. Bangaladesh-2, India-2, Nepal-1, Kyrgyzstan-3, Malaysia-1, Mongolia-3, Thailand-1.

A joint inaugural function of the two courses i.e. the Satellite

Valedictory function of SATMET-10 at SAC (Bopal Campus), Ahmadabad

Director SAC, distributing diploma certificates to the course participants.

Processions of SATMET-10 Students with Chief Guest before the valedictory function.

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 2016. This function was presided over by Shri Tapan Misra, Director SAC &PRL, Dr. Senthil Kumar, Director CSSTEAP, Dr. P Janardhanan, Dean PRL and. Senior Officers from SAC and PRL graced the function.

SATMET-10 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 candidates gained significatnt knowledge during the 3 months Pilot-Project- formulation of a problem of relevance to their country, acquiring data, execution of program. All the SATMET participants successfully made their final project presentations, which were evaluated by A.U professor. All the SATMET students completed Phase-I successfully, and were given PG diploma. In PHASE-II successful participants wil have to do a project work in their own country for one year. On successful completion of the 1 year project work, they can submit Thesis to Andhra University for the award of M.Tech. degree.

The broad Themes of the pilot project include:

- Assimilation of satellite data and impact studies of severe weather using WRF model
- Sounding products - INSAT-3D / AIRS and MODIS data-validation/ Applications.
- Cryosphere (assessment of change)/ over Kyrgyzstan.
- Mesoscale convective studies using satellite data.
- Radio Occultation and Application.
- Structural analysis of Tropical cyclone using high resolution scatter-meter data.
- Now-casting using satellite data.
- Climate modelling Applications.
- Rainfall estimation
- Validation of SAPHIR data from Megha Tropiques.

Valedictory Function

Joint Valedictory 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 PRL was held at SAC (Bopal), on April 24, 2017. The meritorious students were awarded Post graduate diploma in "Satellite Meteorology and global climate". Seven students got first class with distinction, five passed in first class and the remaining one was declared pass. The first three rank holders received CSSTEAP excellence medals and certificates from the

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10TH POST GRADUATE COURSE IN SPACE AND ATMOSPHERIC SCIENCE

The Tenth Post Graduate Course on Space and Atmospheric Science (SAS) was conducted at Physical Research Laboratory (Bopal Campus), Ahmedabad from August 1, 2016 to April 30, 2017. Twelve participants representing two countries of the Asia-Pacific region attended the courses.

The course was spread over two semesters. Faculty members included eminent Scientists/ Engineers from PRL and other Institutions in India. Subjects covered in the 1st semester were Atmosphere, Ionosphere, Ground-Based Techniques, Space Instrumentation and Space Exploration. Each subject was taught in 40 one-hour lectures during the morning hours. Relevant practicals were conducted in the afternoon sessions. For each of these subjects, there were tests, assignments and short seminars which were graded and used for internal assessment of the students. Overall there were 2 assignments, 6 tests, 4 seminars and 6 practicals in the first semester. Lectures for the first semester ended on November 7. Final examinations for the first semester were conducted during the period 13-27 November, 2016. As a part of the programme, the participants were taken on scientific tours to Udaipur Solar Observatory and the infra-red observatory at Mt Abu during 28 November 2 Decemeber, 2016.

Classes for the second semester began on Dec. 5 and ended on Jan 13, 2017. There were 3 theory papers covering topics on Magnetosphere, Solar and Radio Astronomy, and Stellar Astronomy. In the second semester, there were 7 tests, 2 seminars, and 6 practicals.

Course participants at RAC, Ooty

Remote sensing of aerosol properties by using sun-photometer during pilot project

Valedictory Function

Final examinations were conducted during the period 20-27 January.

From February 1, pilot projects started. Each participant chose a topic of her/his research interest and pursued the research under the guidance of a faculty of PRL. The pilot project topics were as follows:

- Temperature and soil moisture change over Ulaanbaatar, Mongolia
- Ozone and its precursors in Ahmedabad: Features of diurnal and day-to-day variations.
- Study of waves and oscillations in the Earth's atmosphere
- Investigation of Atmospheric Greenhouse gases over India
- Determination of aerosol optical depth by using sun photometer
- Study of Aerosol Black Carbon
- Enhancing spectropolarimetry of CZT Imager, AstroSAT
- CCD Photometry of AGNs
- Study of stealth CME and ICME
- Study of halo CME in interplanetary medium during 2011
- Study of Proton Flare Characteristics and Their Relation to CME Dynamics
- Looking at the coronal loop dynamics using numerical simulations

At the end of February, 2017 the students were taken on educational tour to selected national centres of excellence in Space and Atmospheric Science, which included visit to National Remote Sensing Centre (NRSC) and Tata Institute of Fundamental Research (TIFR) balloon facility at Hyderabad, Indian Institute of Astrophysics (IIA) and Centre for Research and Education in Science and Technology (CREST) at Bangalore, RAC and Cosmic Ray Laboratory at Ooty. NRSC is responsible for remote sensing satellite data acquisition and processing, data dissemination, aerial remote sensing and decision support for disaster management.

TIFR Balloon Facility has all aspects of Scientific Ballooning (Balloon Design and Fabrication, Payload Integration with Telemetry, Telecommand and other instrumentation, and finally Balloon Launch, Tracking, Data Collection, Balloon Flight Control, as also Payload Recovery). IIA is a premier institute devoted to research in astronomy, astrophysics and related physics. A visit to Andhra University, was also carried out for the educational records of all participants to be scrutinized for assessing their M.Tech eligibility. The tour lasted till March 10, 2017.

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22ND POST GRADUATE COURSE ON REMOTE SENSING & GEOGRAPHIC INFORMATION SYSTEM (RS & GIS)

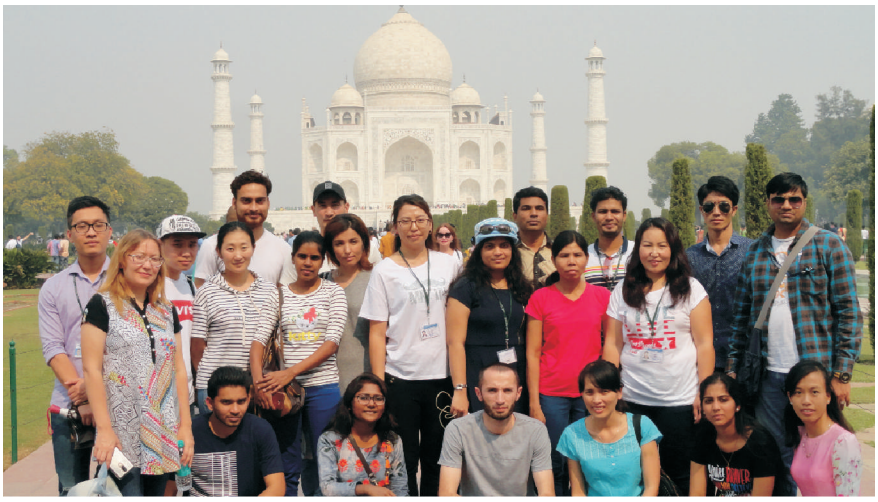
The twenty-second PG course on Remote Sensing and Geographic Information System of CSSTEAP commenced on July 1, 2017 at Indian Institute of Remote Sensing (IIRS), ISRO, Dehradun, one of the host institutions of CSSTEAP. Total twenty-two participants from eleven countries of Asia-Pacific Region viz. four from Viet Nam, three each from Bangladesh, Indian and Mongolia, two each from Sri Lanka and Tajikistan and one each from Kazakhstan, Kyrgyzstan, Nepal, Lao PDR and Myanmar are attending the course. The participants attending the course are from varied backgrounds like Hydrology, Forestry & Ecology, Fisheries and Marine Science, Meteorology, Urban and Rural Planning, Agricultural Science, Geoinformatics, Surveying, Cartography, Geology and Mining, and Disaster Management.

The PG diploma course of 9 months duration consists of 2 semesters, spread in modules. The successful completion of 9 months training leads to award of PG Diploma. The successful candidates subject to qualifying for admission requirements of Andhra University, may carry out a dissertation research work of one year in their home country which will lead to the award of M.Tech. Degree by Andhra University after its successful completion. A few meritorious participants will be granted additional fellowship of five months to one year to complete part of their research work at CSSTEAP/IIRS.

The participants attending the 22nd RS&GIS PG Course have completed the core modules (Module-1A, Module-1B and Module-II) and Module-III (Pilot Project) is currently under progress. In Module-1A participants were imparted

21st PG Course participants along with dignitaries during valedictory function

information on Remote Sensing and Geographic Information System and their application in natural resource management, where the emphasis is on the development and enhancement of knowledge and skills through classroom lecture, tutorials, field visits, seminars and hands on session. The participants were taken to several field excursions for ground truth collection and for interpretation and analysis of satellite data. In Module-1B participants were introduced to the recent trends in RS & GIS and Environmental assessment and Monitoring. In Module-II course participants based on their academic qualification, technical requirement of their parent organization and their professional experience choose one of the eight electives i.e. Agriculture & Soils, Forestry & Ecology, Geosciences & Geo-hazards, Marine & Atmospheric Science, Water Resources, Urban & Regional Planning, Satellite image analysis & photogrammetry and Geo-informatics. In present batch 5 participants each have opted for Urban & Regional Planning, 4 each for Satellite image analysis & photogrammetry and Water Resources; 3 for Forestry & Ecology, two each for Geoinformatics and Marine & Atmospheric Science and one each for Agriculture & Soils and Geosciences & Geo-hazards. Module-III of three months duration, which consists of execution of a pilot project, based on the knowledge gained during the course by utilizing space inputs is in progress and will complete on March 31, 2018. This module equips participants with advanced knowledge and experience in application of EO data and GIS technology in selected mathmatic dicipline.



Participants visiting Taj Mahal (UNESCO World Heritage Site) at Agra.

Participants attending Pre-Symposium Tutorial on Agricultural Monitoring

In addition to the academic activities special efforts were also put for improving the level of competency of spoken English, understanding and writing skills in English of the participants from Asia Pacific Region. English language class after office hours were conducted in campus during the first three months with special emphasis on pronunciation/accent, grammar and vocabulary which could be helpful to the participants in understanding the subjects taught in classes with more clarity.

Participants attending classes

Participants visiting virtual reality facility at NRSC, Shadnagar Campus, Hyderabad

Participants on field excursion

Participants meeting Vice Chancellor Andhra University, Vishakapatnam

The course participants were given an opportunity to participate in the 38th Asian Conference on Remote Sensing (ACRS-2017), during October 23-27, 2017 at New Delhi, which helped them to gain insights into the challenges and opportunities of Remote Sensing and geo-spatial technologies and meet and interact with researchers, scientists, engineers, policy makers, professionals and practitioners from developed and developing countries from and around Asia. In addition the participants were also nominated to attend one day Pre-Symposium Tutorial on Agricultural Monitoring on October 22, 2017, in which the experts from different centers of ISRO provided demonstrations of various recent advances in remote sensing and geospatial technology. During the ACRS meet participants also had an opportunity to visit famous Taj Mahal (UNESCO World Heritage Site) at Agra.

As part of the course curricula the participants were taken for technical visits to Andhra University, Visakhapatnam and National Remote Sensing Centre (NRSC), Hyderabad during December 03, to 11, 2017. During technical visits, participants also had an opportunity to visit cultural & natural landscape in Visakhapatnam, and Hyderabad and have an understanding of Indian culture, heritage and traditions. During first lap of the technical visit, course participants were taken to Andhra University where they attended lectures on specialized topics (on rainwater harvesting, flood mitigation and coastal hazard vulnerability and GIS modelling), met Vice Chancellor of Andhra University and also their documents were verified for finding M.Tech eligibility.

During the second lap of the technical visit, course participants were taken to NRSC, Balanagar and Integrated Multi-mission Ground Segment for Earth Observation Satellites (IMGEOS) facility at Shadnagar. At NRSC Balanagar, participants were apprised about the activities being carried out by the Centre and also had an opportunity to interact with the scientists working on various operational projects involving space based earth observation data. At IMGEOS course participants had an opportunity to see the state-of-art multi-mission ground segment processing enterprise for earth observation satellites and also witnessed real time acquisition of EO data at Shadnagar, Hyderabad. The participants were also shown the virtual reality facility and National Database for Emergency Management (NDEM) facility at NRSC, Shadnagar Campus.

Participants visiting earth station complex for receiving satellite data at NRSC Shadnagar campus

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11TH POST GRADUATE DIPLOMA COURSE IN SATELLITE COMMUNICATIONS (SATCOM-11) AND SECOND GLOBAL NAVIGATION SATELLITE SYSTEMS (GNSS-2) OF CSSTEAP

The Post Graduate Diploma Courses, namely, Eleventh Satellite Communications (SATCOM-11) and Second Global Navigation Satellite Systems (GNSS-2) of CSSTEAP started on August 01, 2017 at SAC Ahmedabad. Total 21 participants from nine countries of Asia Pacific region, namely Bangladesh, Bhutan, India, LaoPDR, Mongolia, Myanmar, Nepal, Sri Lanka and Tajikistan are attending SATCOM-11 course. Similarly, 12 participants from five countries, namely, Bangladesh, India, Mongolia, Sri lanks and Tajikistan are attending GNSS-2 course. The Joint Inaugural function was held on 01 August, 2017 2014 at Bopal Campus, SAC.

Shri Tapan Mishra, Director, SAC, Shri D. K. Das, AD, SAC, Dr. S. P. Aggarwal, Programme Coordinator, CSSTEAP, SMC members, Focal Points, Faculty and other staff members attended the Inaugural Function. After, the traditional rituals, Shri D. K. Das, AD, SAC formally welcomed the course participants and highlighted the activities of SAC. Later, Shri Tapan Misra, Director, SAC, said in his inaugural address, that Navigation technology emerging in a big way and SAC/ISRO significantly contributing to the regional navigation in India's main land and surroundings by establishing the NavIC. SAC is also developing the NavIC receivers and using it in critical applications. He also emphasized the developments in Satellite Technology, such as High throughput satellites etc., and the role played SAC. Dr. S. P. Aggarwal, Programme Coordinator, CSSTEAP, introduced the CSSTEAP programmes and briefed about the

Participants of SATCOM-11 Course with dignitaries

Participants of GNSS-2 Course with dignitaries

opportunities and avenues available in these courses. Dr. Raghunadh K Bhattar, Course Director, SATCOM-11 & GNSS-2 narrated the structures of the courses and gave the guidelines to the participants. Finally, Mr. Vishal Agarwal, Course Coordinator, SATCOM-11 & GNSS-2, proposed the vote of thanks and Mr. V.N. Parekh, Course Coordinator, SATCOM-11 & GNSS-2 anchored the function.

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POST DISASTER (EARTHQUAKE) RAPID DAMAGE ASSESSMENT, MYANMAR YANGON

SHORT COURSES

During 21st GB meeting of CSSTEAP held on December 19, 2016 at New Delhi, UNOOSA proposed that CSSTEAP may provide the support in organization of a training programme on Post Disaster (Earthquake) Rapid Damage Assessment using the latest technological advances in geospatial and space technology for officials of Myanmar at Yangon, Myanmar. Chairman CSSTEAP GB and members approved the proposal.

The Centre for Space Science Technology and Education for Asia and the Pacific (CSSTEAP) along with UNOOSA, UN-HABITAT, and UN-SPIDER designed and developed the course curriculum and conducted the training course from 28 March to 2 April 2017 at Yangon, Myanmar. Its objective was to enhance the capacity for rapid damage assessment using geospatial and Earth observation technologies. The event was conducted as part of the UN-SPIDER's technical advisory services which began in 2012 in the case of Myanmar. The training course was hosted by the Yangon Technological University in collaboration with Ministry of Social Welfare, Relief and Resettlement, and the Myanmar Engineering Society and Myanmar Earthquake Committee. It was organised as a recall of the Chuak earthquake in August 2016 that severely damaged some of the religious structures in the heritage site of Bagan, with the purpose of developing capacities in use of earth observation and geospatial technologies for post-disaster rapid damage assessment

A total of 44 participants from 16 disaster management agencies and stakeholder departments participated in the training programme. The participants were introduced to the concepts of hazard and vulnerability, Earth Observation (EO) satellites for disaster management, Geographic Information System (GIS), visualization of GIS data and satellite images. The participants learned through interactive lectures and hands-on sessions, the role of international emergency mechanisms established by space agencies such as the International Charter Space and Major Disasters and Sentinel Asia; as well as on the use of FOSS4G (Free and Open source software's for Geoinformatics), latest trends of Digital Image Processing such as textures, colour spaces etc., 3D modelling using TRIVIM software and mobile based field data

Participants of the course

collection using crowd-sourcing techniques based on open-source software (Open Data Kit). Lectures and hands-on exercises were delivered by a total of eight faculty members from four international organizations namely: CSSTEAP(5 nos.), UNOOSA(1 no.), UN-SPIDER (1 no.) and UN-HABITAT (1no.). 70% teaching load was taken up by IIRS/CSSTEAP faculty. The major highlight of the course was that more than 60% of the time was devoted to hands-on sessions to facilitate the understanding and develop the skill for Rapid damage assessment. At the end online feedback was taken from the participants. The efforts of CSSTEAP, UNOOSA, UN-HABITAT and UNSPIDER were appreciated by the participants and it was indicated that the course has provided a useful understanding of current geospatial technology and solid foundation for rapid damage assessment.

LIDAR REMOTE SENSING AND ITS APPLICATIONS

SHORT COURSES

In recent times Light Detection and Ranging (LiDAR) has emerged as a powerful remote sensing tool for acquiring very accurate and high spatial resolution 3D information of the land surface features. These sensors can be mounted on various fixed or mobile platforms, including Unmanned Aerial Vehicles (UAV), airborne, helicopter. This technology is being effectively used in various applications for e.g. urban infrastructure mapping and monitoring, building 3D city models, archaeology, mining etc. Effective utilization of this technology requires trained human resources, with this view CSSTEAP organized a 2 week short course on "LiDAR remote sensing and its Application" for participants form Asia- pacific countries.

Participants of LiDAR Remote Sensing & its Application

The course commenced on May 15, 2017 with 21 participants from Bangladesh, India, Kazakhstan, Mongolia, Nepal, Sri Lanka, Tajikistan and Thailand. The overall objective of this training course was to provide awareness about the concepts of Lidar Remote Sensing, aspects of data processing and potential of Lidar data in various applications. The course was designed in a modular structure which provided a blend of theory and hands on practical exercises. It consisted of two modules: First week covered fundamentals of Lidar, Various platforms: Satellite Aerial and terrestrial, Data processing concepts: georefrencing and feature extraction. A field excursion to Mussorie was also organized.

2nd week covered applications of Lidar in Forestry, urban, geosciences and disaster atmosphere. Lectures were delivered by faculty from IIRS, NRSC, IIT Kanpur, SASE, IRDE and NARL. In the last 2 days the participants carried out a small cases study in groups on and presented their work

A formal feedback was taken at the end of the course. In general, all the participants rated the course as very good to excellent in terms of objective, course program design and implementation. The valedictory function was held on May 26, 2017

WEATHER PREDICTION USING NWP MODELS

SHORT COURSES

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 a Short course on weather prediction using NWP models, which commenced on 3rd July at SAC (Bopal Campus), and ended on 14th July 2017.

Twenty-five participants from eleven countries in Asia-Pacific region have been trained in this course. They are mostly operational forecasters, meteorologist, and researchers in their own country, especially working in NWP. The participants are from the countries like Bangladesh, India, Indonesia, Kazakhstan, Malaysia, Mongolia, Nepal, Qatar, Tajikistan, Thailand and Vietnam.

This NWP course was for two weeks, and the course is well structured in such a way to get maximum benefit to the students. The 1st week started with history of NWP, model resolution etc., familiarization of Linux OS, Spaced base observation for NWP, solving NWP equations, forecasting processes, Data assimilation, setting of WRF model, WRF assimilation system. And 2nd week started with physical processes & parametrization, Assimilation of observational data in WRF, assimilation of land surface data, super ensembles, rainfall assimilation, radiance assimilation, assimilation system for tropical cyclones, AOS assimilation and Dust storm forecasting.

Valedictory Function of Short Course in NWP at SAC (Bopal Campus), Ahmedabad

In addition to class room lectures during the morning hours, practical using Weather Research Forecasting (WRF) model, were conducted in the afternoon sessions. Most important highlight during this practical's, was the students were taught to how to install the WRF model in their computer. They were also taught how to assimilate the local observation/satellite data of their country in the model. This was well appreciated by all the students.

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UAV REMOTE SENSING AND ITS APPLICATIONS

SHORT COURSES

Acquisition of remote sensing data using small unmanned aerial systems (UAV) more properly known as drones has seen a significant growth in recent years across the world.

UAV's have significant advantage because of their flexibility, low cost and provides a very high resolution data. It is an emerging technology and there is a need share the knowledge, theoretical and practical experience in order to utilize the full potential of this technology.

With this view CSSTEAP organized a two week special course on UAV remote sensing and its Application, to create awareness among the remote sensing professionals on the potential of UAV remote sensing, challenges in data processing and its application for the participants from Asia pacific countries. The course curriculum was designed to provide a useful understanding of current advances in geospatial technology using UAV and serve as a solid foundation for handling high resolution data specifically for DEM and ortho-rectification of large datasets at a fine resolution.

Participants of UAV Remote Sensing & its Application

The course commenced on June 12 with 23 participants from Bangladesh, India, Indonesia, Kazakhstan, Kyrgyzstan, Maldives, Nepal, Sri Lanka, Tajikistan and Uzbekistan. The course was a blend of lectures, hands-on exercise and field exercise covering topics like fundamentals of UAV remote sensing, data processing and information extraction, potential advantages of UAV data in natural resource management and disaster management. A demonstration of data acquisition process using a quadcopter and field work to demonstrate GPS data collection for processing UAV data was also organized.

Lectures were delivered by faculty from IIRS, NESAC and MNCFC. As a part of the course, participants also carried out small project in groups addressing data processing aspects and potential of UAV data in various applications like, forest, agriculture, land cover mapping, river and glacier studies for 3 days and presented their results.

A formal feedback was taken at the end of the course. Participants have appreciated and expressed that the theoretical concepts and practical knowledge imparted was very effective. The valedictory function was held on June 23 2017.

6TH SHORT COURSE ON SMALL SATELLITE MISSIONS

SHORT COURSES

The sixth series of Short course on small satellite mission was conducted at CSSTEAP, IIRS, Dehradun from November 20 to December 01, 2017 for capacity building on small satellite in Asia Pacific and ASEAN countries. About 40 participants from 15 countries attended the course. The topics related to small satellite technology like orbits, satellite design, fabrication, Assembly, testing, launch base activities and launch vehicle interfaces were covered. Additionally the system engineering programme management, qualification control activities, the mission planning, on orbit operations and commanding network were also covered under the course. These lectures were delivered by well experienced Scientist/Engineers working on satellite systems at ISRSO Satellite Centre, ISRO Telemetry, Tracking and Command Network Centre, Bangalore and Indian Institute of Remote Sensing Dehradun. These lectures were supported by demos, videos and videoconference with ISAC. A Quiz program on Space systems and space events was conducted for more involvement of participants which has given very good response. Assignments related to orbits and various sub-systems were given to participants and it was well responded. A Satellite Model making competition was conducted and outputs were shown. Satellites were designed with innovation.

Small Satellite Missions participants attending lectures

Small Satellite Missions participants with their satellite models

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PILOT PROJECT ABSTRACTS

Project Abstracts of 21st Post Graduate Course on Remote Sensing and Geographic Information System

1. Exploring Cloud Based, Geospatial Processing Infrastructure, to Study Water Spread in Uttar Pradesh
2. Web GIS based Solving for Advertisement of Real Estate
3. Geospatial Data Processing in Python-A Case Study: Impact of Classification Techniques on Land Use and Land Cover Mapping and Land Use and Land Cover Change Prediction in Haridwar, Uttarakhand State, India
4. Assessment of Rainfall Products for the extreme rainfall events over the North-West Himalayan Region
5. Study the Seasonal Variation of Chlorophyll-a with Suspended Sediments Concentration in Dondra Bay, Sri Lanka using LANDSAT-8
6. Impact of Climate Change on Runoff Response of Asan River Watershed of Dehradun District, Uttarakhand State, India
7. Decision rule based forest fire detection and analysis of the relationship between Land Surface Temperature (LST) & Burn severity
8. Soil Moisture Estimation of Bare Agriculture Fields Using Hybrid Polarimetric RISAT-1 Synthetic Aperture Radar Data
9. Application of 3D Close Range Photogrammetry for Mapping Flood Inundation in an Urban Scenario
10. Potential of Space borne Bistatic Polarimetric Interferometric Modelling For Vegetation Height Estimation
11. Information Extraction using Ground based Hyperspectral Remote Sensing Data
12. Study of peri-urban dynamics using high resolution data and GIS
13. Evaluation of Open Spatial Data for Topographic Mapping
14. Analysis and comparison of DEMs and orthophotos from UAV data, generated by various specialized software
15. Investigating Impervious Surface Area, NDBI and NDVI as Indicators for Urban Heat Island Effect using LANDSAT Imagery Case: Delhi
16. Analysis of Urban Green Spaces in Dehradun; Using Remote Sensing and GIS
17. Sediment yield and reservoir sedimentation assessment using geospatial techniques
18. Forest Ecosystem Services Assessment by using Geospatial Approaches in Pali Gad Micro-Watershed Area of Garhwal region of Uttarakhand states, India
19. Application of 3D Database in Estimation of Flood Inundation Area using Trivim

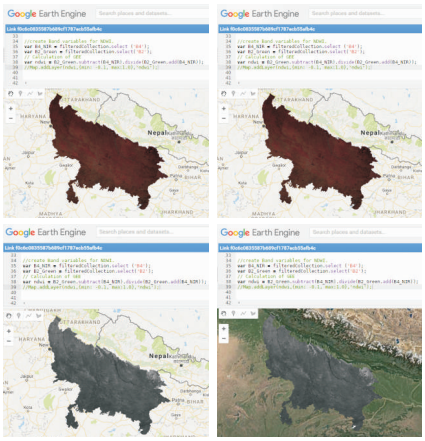
Exploring cloud based geospatial processing infrastructure to study water spread in Uttar Pradesh

The new form of computing infrastructure called "Cloud computing" is now being used for storage and processing of geospatial data. A cluster of servers can solve "embarrassingly parallel" tasks, such as per pixel calculations (classification, band math, etc.) - in a very short duration. There are many such initiatives globally including NASA Earth Exchange, Amazon Web Services, Google Earth Engine (GEE) etc. This creates an environment where scientists can collaboratively share data, algorithms, and visualizations using URLS's. Current applications include: detecting deforestation, classifying land cover and land cover change, estimating forest biomass and carbon, and mapping the world's roadless areas. In this project, an attempt was made to combine the power of cloud GIS to map flood prone areas in the Indian state of Uttar Pradesh.

Indexes derived from LANSAT satellite imagery such as Normalized Difference Water Index (NDWI) and Normalized Difference Vegetation Index (NDVI) are generated on-the-fly for both the pre-monsoon and post-monsoon months for the study area. The water spread area for both the durations were compared. Also intra-annual water spread change were compared. Spatial change maps were generated and results were quantified. Land use land cover data, available from Bhuvan thematic services (www.bhuvan.nrsc.gov.in) was used to validate the study. Additional efforts were also made to use MODIS and Sentinel SAR data to overcome issue of cloudiness.

Application of 3D Database in Estimation of Flood Inundation Area using Trivim

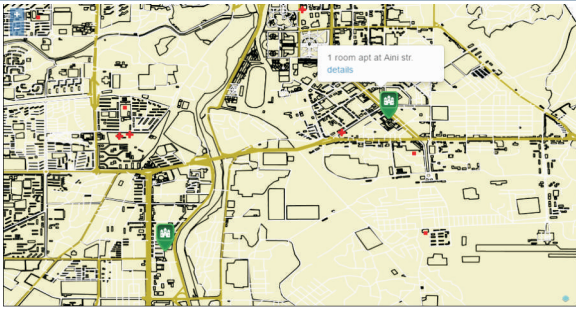
In 2016 Kazakhstan also experienced widespread flooding in the central part of the country. The main objective of the present study is to estimate the flood inundation area around Ram Jhula Bridge across river Ganga in Rishikesh using Trivim software. Trivim is open source freeware application enables generation of 3D street scenarios using a set of 2D images based on the principles of close range photogrammetry). The application comprises of a series steps which generates a photo textured 3D model that can be exported for 3D visualization in an earth explorer such as Google Earth, Bing 3D, ISRO Bhuvan 3D. Testing and debugging the latest version of Trivim software, which is under R&D at Indian Institute of Remote Sensing, is also part of the work besides the estimation of flood inundation area. The flood inundation area was estimated by using DEM, 3D-model generated by Trivim and map of the area. To get the best result various DEMs, such as ASTER, SRTM and different versions of Cartosat-1 were utilized. The optimum DEM for the area and purpose of study was chosen Cartosat-1 version 3 DEM with horizontal resolution 30 m and vertical resolution 4 m.



Pre-monsoon imagery (FCC & NDWI) of Uttar Pradesh in 2015

Web GIS based solution for advertisement of real estate

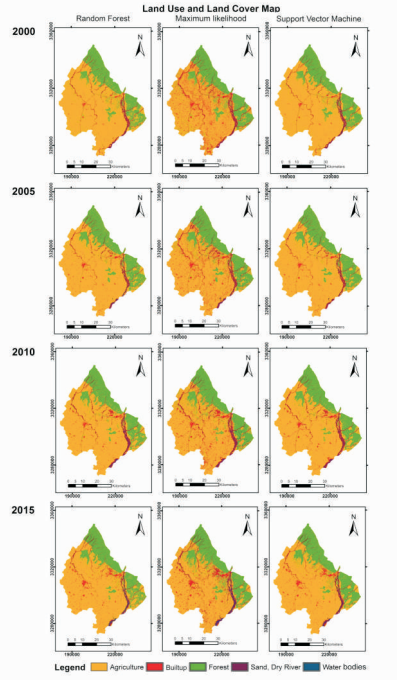
Today, in a global network, a multimillion society that simply visits the pages using mobile phones and personal computers, which allows almost everyone to stay online all the time. That is why Internet advertising is needed, for example, contextual, media, advertising on



thematic resources, brings simplicity and convenience. From time immemorial, the most important property in a person's life is real estate. In this sense, you need to clearly present your future home, as it should look. You need to consider all the conditions which are suitable for you and your family, the advantages and disadvantages as well as alternative options to choose the best option. Real estate isn't just about sticks and bricks, it's about finding the right place for you to live. We deliver information that not only shows you the properties that fit your criteria but the neighborhood & community amenities that fit your lifestyle. This work meets these needs, especially in Dushanbe. The capital of Tajikistan, a city which is a center for the largest scientific, cultural, political, economic, industrial and administrative center of the country. In order to realize our project, we created a Database based on PostGIS for storage and to have full access to GIS data, created a WMS to visualize GIS data in a web and created an interface for the web browser, so that the visitor can easily add.

Geospatial Data Processing in Python A Case Study : Impact of Classification techniques on Land Use and Land Cover Mapping and Land Use and Land Cover Change Prediction in Haridwar District, Uttarakhand State, India

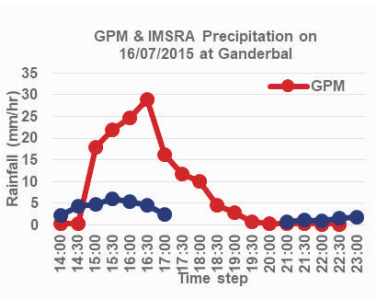
Geospatial technology is very much helpful to monitor land use / land cover changes using classification method. But the different classification techniques give different thematic map from same satellite image. In this study, to study the impact of these techniques on change detection and land use and land cover change prediction in Haridwar District, Uttarakhand State, India. Using Landsat satellite image from the United States Geological Survey for 4 year including 2000, 2005, 2010 and 2015. We analyse three different classification techniques using python programming language including Random Forest, Maximum likelihood and Support Vector Machine techniques. These techniques are used with similar AOI dataset for classification in 5 classes including Agriculture, Builtup, Forest, Sand/Dry River and Water bodies. The results show Random Forest technique performs the best, Support Vector Machine and Maximum likelihood technique respectively. In that case we are observed that Random Forest and Support Vector Machine techniques performs the best for classification of agriculture and forest area, Support Vector Machine technique performs better classification for Sand/Dry River and Water bodies. Maximum likelihood technique misclassified Agriculture area into Builtup. Therefore classification techniques selection is very an important extract for map generation and proper analysis should be considered on input data to suit the classification technique.

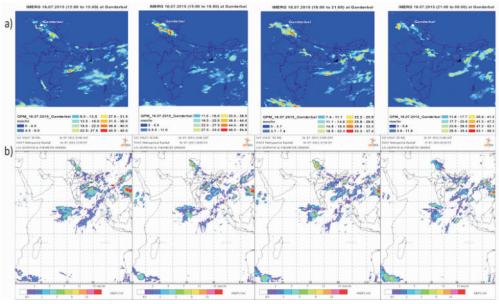


Land use and land cover maps 2000-2015 in 3 classification techniques

Assessment of rainfall products for the extreme rainfall events over the North-West Himalayan region

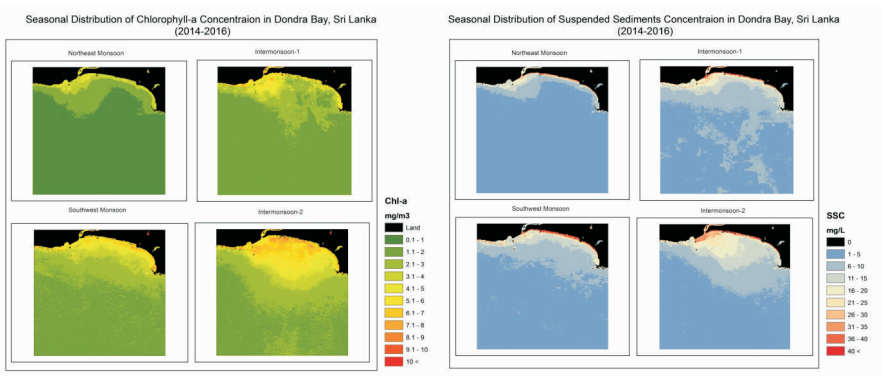
Using remotely sensed rainfall data sets from four different satellites an assessment of the potential of these satellites to analyze the extreme rainfall events has been carried out in this study. The analysis of the extreme rainfall events has been carried out for the selected cloud burst events over the North-West Himalayan region in space and time. Satellite derived precipitation estimates from TRMM 3B42 V7, GPM-IMERG, Kalpana-1 IMR and INSAT -3D IMR have been assessed thoroughly during the rainy season for the period 2010 - 2016. Present analysis has been carried out in two ways one is the time series analysis and the other one is spatial pattern analysis. We note that on an average GPM-IMERG and TRMM 3B42 V7 perform better than the other two data sets in capturing the location and intensity of rainfall, however satellite derived precipitation underestimates the amount of the rainfall during the cloud burst events. The propagation of rain bands prior, during and after the cloud burst events has also been studied using the four satellite data products, and it is noted that in general all the satellite products reveal more or less similar rainfall spatial pattern at large scale, but GPM-IMERG and TRMM 3B42 appear to perform better than the other two rainfall data sets during the cloud burst events except the for Leh cloud burst events. Compared to the ground based IMD gridded rainfall data set, huge underestimation in the amount of rainfall is noted for most of the reported cases, and this amount of underestimation varies from location to location. Needless to say, newly released GPM-IMERG precipitation data demonstrates good potential in capturing the location and intensity of the cloud burst events over the North-West Himalayan region as compared to the other existing satellite derived rainfall data sets. Present study is a contribution to the ongoing study of extreme events on the mountainous region. Modification in existing rainfall retrieval algorithms is suggested based on the results obtained in the present work.





Study the Seasonal Variation of Chlorophyll-a with Suspended Sediments concentration in Dondra Bay, Sri Lanka using Landsat 8

Satellite remote sensing has become increasingly helpful in studying oceans and their many biological and physical processes. In present study seasonal variability of chlorophyll-a is studied along with SSC focusing the Nilwala river outfall located in Dondra Bay, Sri Lanka using Landsat-8 OLI data. Study area is rich in bio-diversity with shallow water coral reefs,



mangroves, turtles and migratory fishes such as Blue whales, Dolphins, Tuna and also important in economic aspects due to well established fishery and tourism industry. Sediments brought by the Nilwala river mouth dominate the physical and biological processes of study area. Therefore monitoring SSC is crucial for coastal ecology as it can directly affect the turbidity and determines the amount of light availability at depth for primary production. Sediments concentration varies according to the season depending on the rainfall and productivity also can be affected accordingly. Primary productivity is proportional to the chlorophyll-a concentration. Therefore, this study was carried out taking four seasons into account: Northeast monsoon (Jan-Feb), First Intermonsoon (March-April), Southwest Monsoon (May-Sep) and Second Intermonsoon (Oct-Nov). Landsat 8 OLI provides a better spatial resolution to monitor coastal processes in detail than existing sensors dedicated for monitoring ocean color. Algorithms developed by NASA (2015) for chlorophyll-a (OC2) and Tassan (1994) for SSC were applied in this study to generate chlorophyll-a and SSC maps for 3 year of data (2014-2016). Accordingly, seasonal maps and anomaly maps were generated. Nearshore and offshore seasonal variability of these two parameters were analyzed statistically with regression analysis. The analysis shows that throughout the year nearshore waters has negative correlation (r=-0.50311) between average SSC and chlorophyll-a and offshore waters has positive correlation (r=0.625443). Correlation between seasonal averages also shows negative correlations over near shore and positive correlations over offshore except in southwest monsoon period which is having high precipitation compared to other seasons. Highest average SSC & Chlorophyll-a was resulted in second intermonsoon season respectively 8.2 mg/L & 4.0 mg/m3 over offshore and 31.9 mg/L 5.2 mg/m3 over nearshore.

Impact of Climate Change on Runoff Response of Asan River Watershed of Dehradun District, Uttarakhand State, India

Climate change refers to the variation in average surface temperatures on Earth. Climate change has potentially huge impacts on water resources basically increasing runoff due to drastic land use change i.e. deforestation and rise in temperature. In order to assess the impact of land use and climate change on water resources, hydrological model like Soil and Water Assessment Tool (SWAT) is very significant along with Geospatial technology. SWAT model was use to assess the effect of climate and land use change over hydrological regime of Asan Watershed of Dehradun district, Uttarakhand, India. The geospatial dataset such that land use map was prepared from Landsat 8 satellite data using un-supervised technique. The model was used to assess the impact of land use change over a decade from 2005 to 2015. To assess the meteorological impact over hydrology of Asan Watershed, future meteorological data was downloaded from Centre for Climate Change Research - Indian Institute of Tropical Meteorology. SWAT model has proven to be an effective method of evaluating land-use change effects on hydrological behavior of watershed. Figure (1): Simulated Runoff of land use/ land cover scenario at 2005 and 2016.

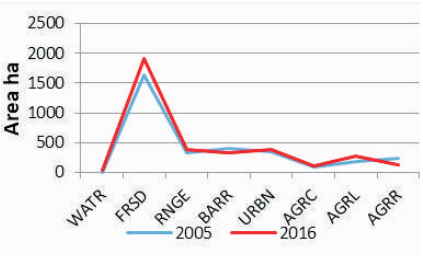


Fig. 1: Simulated Runoff of land use/ land cover scenario at 2005 and 2016

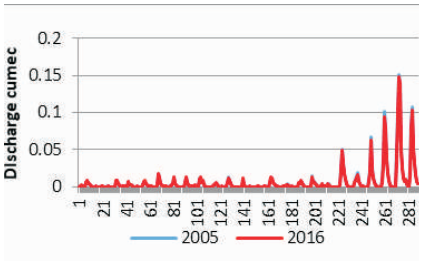


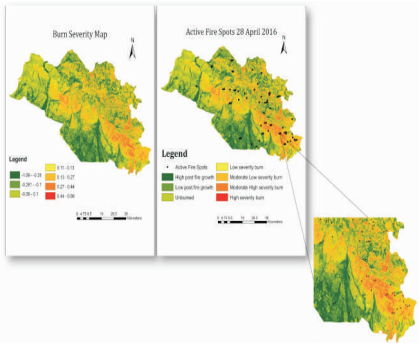
Fig. 2: Land use change in Sub-basin 47

Decision rule based forest fire detection and analysis of the relationship between Land Surface Temperature (LST) & Burn severity

As per the Forest Survey of India Report, 2011, India has forest cover of 692,027 km2, comprising 21.05 percent of the total geographic area of the country. Out of total forest area, very high, high and frequent forest fires damage are noticed over 0.84 percent, 0.14 percent and 5.16 percent of the forest areas respectively. Thus, about 6.14 percent of the forests are prone to severe fire damage. Forest fire is considered as one of the major cause of degradation of forests in India (Roy, 2000) that cause large scale destruction to the forests ecosystems. Forest fires may be beneficial to some ecological functions, however their negative impacts far exceed their benefits. This is because forest fires are a threat to the natural environment, wild life and their carbon emissions contribute to greenhouse gases. These, makes the study of forest fires important.

Steady raise in availability of Landsat data creates new opportunities for fire science and management that require reliable information. Advancement of MODIS (Moderate Resolution Imaging Spectroradiometer) aboard TERRA and AQUA platforms created revolution though it provides data at a coarser resolution. Taking advantage of the spatial resolution of Landsat, Wilfrid Schroeder et al., 2015 developed an active fire detection algorithm with Landsat 8 OLI (Operational Land Imager), which I implemented on Nainital, Uttarakhand for Indian context. The Landsat-8 active fire detection algorithm is driven by the fire sensitive SWIR channel 7 data, exploiting the emissive component of fires in the 2.2 µm spectral window. During the daytime orbits the emissive fire component is mixed with the background, which is dominated by the reflected solar component. In order to separate those, we use the NIR channel 5 data that are mostly unresponsive to fire-affected pixels, though highly correlated to the SWIR channel data over fire-free surfaces (Giglio et al., 2008). Burn severity can be evaluated using dNBR (differenced Normalized Burn Ratio) and a better result is obtained through Multi index (NBR, MIRBI and SWIRindex), Lufuno Vhengani et al., 2015

Besides active fire detection, assessing the spatio temporal

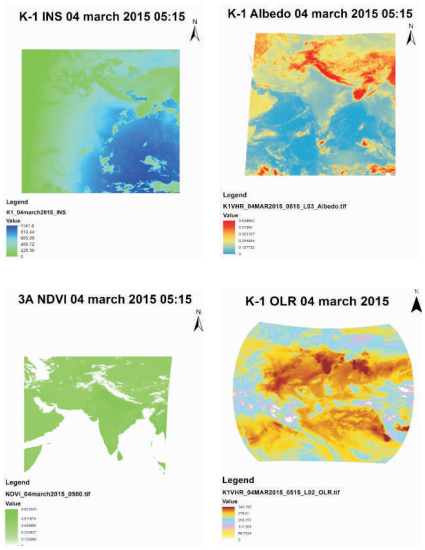


patterns of Land Surface Temperature (LST) and burn severity using series of Landsat 8 images is also performed. Pronounced changes are identified in LST within the areas of burn severity. Burn severity is categorized in to seven from high post fire growth to high burn severity. As the time progresses after fire, LST goes on decreasing due to post fire growth vegetation. Spatial patterns of severity and post-fire LST obtained from Landsat time series enable an evaluation of the relationship between these variables to predict the natural dynamics of burned areas. The maps obtained from the steps above are published in WMS (Web Map Service) using a free and open source server to share geo spatial data, Geo server

Soil Moisture Estimation of Bare Agriculture Fields Using Hybrid Polarimetric RISAT-1 Synthetic Aperture Radar Data

Continuous evapotranspiration (ET) measurements at different scales are important in hydrology, agriculture, and also in other field studies. ET is a one of the key process in hydrological cycle. It mainly depends on characteristics of land surface, incoming solar radiation, and atmospheric condition of the area. Over the last 20 years, the scientists has been interested in estimating

evapotranspiration using remote sensing. The main advantage of estimation of ET using remote sensing is the ability to represent spatial and temporal dynamics at desired scales. For this reason, different models/ techniques have been developed to solve surface energy balance equation for estimating ET using remote sensing observations, to name a few SEBAL (Surface Energy Balance Algorithm for Land, Bastiaanssen, 2000, Bastiaanssen et al., 1998a, Bastiaanssen et al., 1998b and Jacob et al., 2002), S-SEBI (Simplified Surface Energy Balance Index, Roerink et al., 2000), SEBS (Surface Energy Balance System, Jia et al., 2003 and Su, 2002) and TSEB (Two-Source Energy Balance, French et al., 2003, Kustas and Norman, 1999 and Norman et al., 1995) are operationally used remote sensing based ET estimation techniques. However, most of these techniques use data from low earth orbit EO satellite data for estimation of ET. This limits the temporal receptivity of ET estimation. On the other hand Geo-stationary satellite provide almost same data products at higher temporal resolution and slightly compromised spatial resolution. So, in the present study data from Indian Geo-stationary satellites (INSAT-3A, 3D, KALPANA-1) has been used to solve the energy balance equation to derived continuous-instantaneous ET at hourly time scale. The attempt has also been made to validate the results using ground observed ET.



Application of 3D Close Range Photogrammetry for Mapping Flood Inundation in an Urban Scenario

Close range photogrammetry offers the possibility of obtaining the three-dimensional (3D) coordinates of an object from two dimensional (2D) digital images in a rapid, accurate, reliable, flexible and economical way. This study focuses on the generation of 3D street scenarios using a 2D image based on the principles of close range photogrammetry. Cost and Time is main key issue for this approach. In this project, we are attempting to have a simple and cheapest solution to create virtual 3D buildings of a city by using simple photographs based on close range photogrammetry. In this study, it used simple digital images which obtained by using digital camera (NIKON D5300).

Various commercial software are available for the image processing and 3D modeling. Most professional 3D software is expensive, however there is always some free software that one can use and make 3D model out of it. In this study Trivim is used to make 3d street view using the principle of close range photogrammetry.

The Dehradun is the largest and capital city of Uttacharal state. Vijay colony ward is including in Dehradun city in Uttarakhand state, India. The main object of this study is to generate the 3D model of building in flood simulation of the urban area based on close range photogrammetry.

Further, DEM generated from cartosat stereo pair was used to simulate of estimate the inundated area. The inundated area was overlaid with georeferenced 3D model to estmate the buildings affected. Based on the building effected the amount of human and property loss during flooding was estimated.

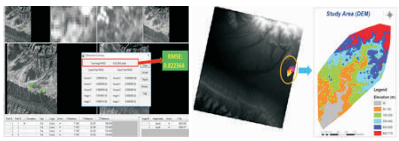


Fig 1: Cartosat Dem with Study Area

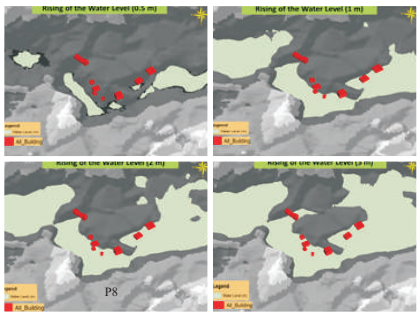
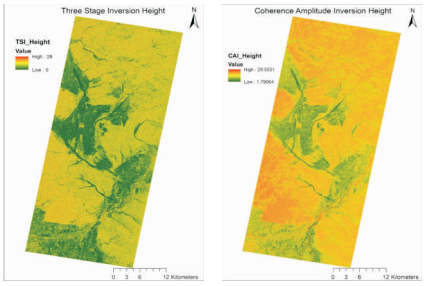


Fig 2: 3D building in Flood Simulation Area

3D building of the flood simulation area result has proved to be a good solution for the decision make. So, the flood inundated area was estimated for the calculation the height of the 3D building in urban area.

Potential of Space-borne Bistatic Polarimetric Interferometric SAR Modelling for Vegetation Height Estimation

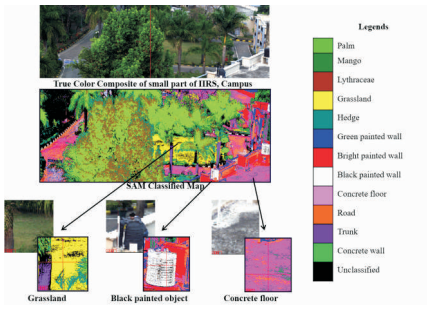
Forest Height is an important indicator of Forest Health. Further Forest Biomass can be calculated using the extracted forest height. Therefore it is real requirement to robust, easy method to monitor Forest condition frequently to better Management activities. Polarimetric Interferometric SAR (PolInSAR) is considered as recent advancement, used for the Vegetation Height estimation Algorithms which is the combination of both Polarimetry and Interferometry hence allows to identify the Scattering Patterns of the Target as well as locating the Scatterer in the Vertical Space. This study is an attempt for examine the potential of bistatic PolInSAR data for Vegetation Height estimation using Coherence Amplitude Inversion Technique (CAI) and Three Stage Inversion Technique (TSI) and the Validation of the results with the Field measured Forest stand height over Barkot and Thano forest, India. As a first spaceborne single pass polarimetric Interferometer in the space, by utilizing TanDEM-X mission data allows to minimizing the error of decorrelation in coherence thus improving the height sensitivity of the Inversion procedure. The penetration capability of the X band is relatively lower than the P, L, S and C radar bands but the high spatial resolution of the data is compensate that effect. The present work, Complex Coherences of Lexicographic Linear (HH, HV, VV), Pauli (HH+VV, HH-VV, HV+VH), Circular (LL, RR, LR) and Optimal basis was calculated as a major input for PolInSAR inversion process. Special attention required when generation of Vertical Wavenumber (Kz), because vertical Wavenumber is the parameter commonly used to express the effective base line. The vertical Wavenumber scales the interferometric phase to height. In the case of TanDEM-X, the



parameter used to express the effective spatial baseline is the height of ambiguity. Threfore carefuly selection of these parametrs highly effected for the accuracy of the results of this study. The present Study concluded about the best Polarisation combination to represent the Surface and Canopy scattering as input for CAI algorithm by estimation of the ground to volume scattering ratio. Validation is implemented with the 100 samples of Field measured Forest height and derived height and concluded the most suitable Algorithm for bistatic PolInSAR Vegetation Height estimation is TSI algorithm with the statistical analysis.

Information Extraction using Ground based Hyperspectral Remote Sensing Data

Hyperspectral Remote Sensing (HRS) is one of the most powerful technology to extract information from the earth and considered as significant breakthrough in remote sensing. HRS sensors can acquire 200 or more spectral bands in a very precisely defined spectral regions. HRS datasets have potential for accurate and detailed information extraction than any other conventional remotely sensed data. HRS images are spectrally rich and provide ample spectral information to identify and distinguish spectrally unique materials. Available airborne/ spaceborne HRS datasets have limitations of coarser spatial resolution and due to that sometimes it's very difficult to identify land cover features and interpret the mixed pixels. So there is a need of high spatial resolution hyperspectral datasets which can be a great help to deal with the real world scenario of mixed pixels and precise



information extraction from earth surface.

This research is concerned with the improved urban land cover

information extraction using Ground Based Hyperspectral Remote Sensing (GBHRS) for solving the object recognition problem. In this study GBHRS data in visible near infrared (VNIR) and Shortwave Infrared (SWIR) range are used. Sensor error correction is carried out to remove some noisy bands and then it is converted to reflectance. Spectral similarity analysis of the reflectance data was carried with the ground spectra of different land cover features collected using spectro-radiometer. After that Spectral Angle Mapper (SAM) classification was performed on GBHRS reflectance data and results revealed that most of the land cover features were clearly discriminated from each other. This clearly indicates that GBHRS can be used as a standard method in field based land cover/ land used feature extraction studies.

Study of peri-urban dynamics using high resolution data and GIS

The history of urban growth indicates that urban areas are the most dynamic places on the Earth's surface. Most often the trend of urban growth is towards the peri-urban areas and the extent of peri-urbanization drives the change in land use/land cover pattern. Dehradun city, which is the provisional capital of Uttarakhand, has emerged as an important business, educational and cultural destination in North India. The decadal population growth rate of Dehradun has jumped up from 25% in 1991-2001 to 33% in 2001-2011. Unregulated increase of built-up in peri-urban areas, in form of encroachment on agricultural land, green covers has caused environmental and hydrological problems. In this context, modelling of growth in peri-urban areas is an innovative tool which provides an understanding of the urban growth process and the variables that drive it. Hence, increased research interest is now being directed to the mapping and monitoring of peri-urban growth using GIS and remote sensing techniques, which serves as a spatial input to the modelling exercise.

Dehradun city, peri-urban area (Pathri Bagh ward, Sarswati Vihar ward, fringe area) is between latitudes 30°16'30"N and 30°18' 30"N and longitudes 78°01'00"E and 78° 02'30"E. The objectives of the present study is to investigate the pattern of peri-urban dynamics in the Dehradun area for three time period (i.e., 2000-2005, 2005-2010 and 2010-2014) high resolution satellite data (IKONOS-1, Cartosat-1) and Geographical information system.

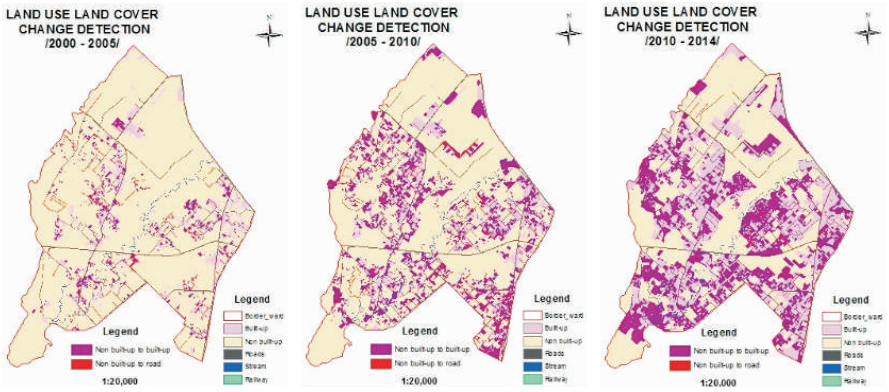
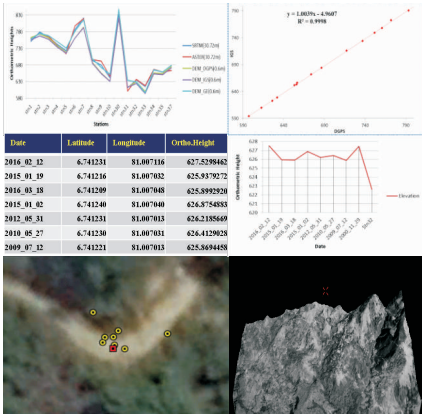


Fig. 1. Peri-urban LU/LC detection using temporal datasets of year 2000-2005, 2005-2010, 2010-2014.

Accuracy assessment of the land use/ land cover (LU/LC) classification results showed an overall accuracy of 96.7% for year 2000, 95.9% for year 2005, 96% for year 2010 and 96.8% for year 2014. The LU/LC change detection showed that built-up increased by 5.7% during 2000-2010 and by 2.6 % during the period 2010-2014, while agriculture, barren land and water body have decreased. Urban growth dynamics is a highly complex and nonlinear phenomena which can be modelled using various mathematical models each coming with their own sets of merits and de-merits. In this study an ANN based approach was implemented for modelling the non-linear peri-urban dynamics. The model was calibrated for the time period 2000-2005 and validated for time period 2005-2010. The calibrated model was then again run for projecting the future growth trend in the study area for year 2014 and beyond. The proposed model will not only provide a understanding of the peri-urban growth process, but will also provide a what if tool to the city planner's for sustainable urban development.

Evaluation of Open Spatial Data for Topographic Mapping

Open Spatial Data increase the availability of inputs, efficiency, and feasibility for topographic mapping; especially in inaccessible areas. A quantitative and qualitative evaluation of open spatial data is essential before use them for topographic mapping. In this study International GNSS Service data were used through Precise Point Positioning to achieve accurate positions and elevations from Differential GPS field observed data. Also the open Digital Elevation Models with other open spatial products were compared with photogrammetrically derived ones. The temporal positional uncertainty of the Google Earth and its impact to elevation was comparatively analyzed with DGPS data. Finally the achievable accuracy and scale level from optical and microwave imageries were assessed. Field observed GNSS data were differentially processed with IGS station data. Those processed data, Google Earth data, and field observed GNSS data have been used to photogrammetric DEM generation, and DEMs and their derivatives were statistically and visually compared. The Google Earth positions and elevations for known stations were extracted from temporal images and statistically analyzed. Then the post processed Sentinel 1and 2 data ware fused, Ortho-rectified, and specific features were extracted. Recommended algorithms and statistical analysis were done to determine the accuracy and the scale. It was found that data of IGS stations which were established in well-conditioned triangle with study area can be used to improve the accuracy of field observed data. Also different open digital elevation models have inherent errors and photogrammetric DEMs elevation values ware changed according to the Ground Control Point source. Google Earth position for particular object or feature was changed along the temporal images. Also the



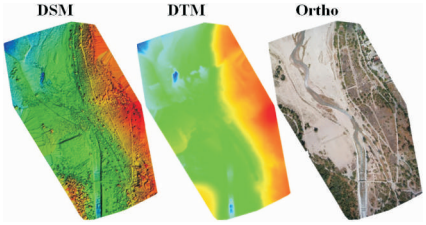
Date	Latitude	Longitude	Ortho.Height
2016_02_12	6.741231	81.007116	627.5298462
2015_01_19	6.741216	81.007032	625.9379272
2016_03_18	6.741209	81.007048	625.5992920
2015_01_02	6.741240	81.007040	626.8754883
2012_05_31	6.741231	81.007013	626.2185669
2010_05_27	6.741230	81.007031	626.4129028
2009_07_12	6.741221	81.007013	625.3694458

elevation was changed according to the positional changes, and flat area had less elevation variation than hilly area. When using the open DEMs directly or open elevation services for particular application, the horizontal accuracy as well as the vertical accuracy should be considered. Especially in Google Earth, the wrong positional coordinate gives incorrect elevation value. These results lend to support to the idea that the open spatial data have advantages for topographic mapping, and they have uncertainties that should be sensibly evaluate before the use.

Analysis and comparison of DEMs and orthophotos from UAV data, generated by various specialized software

At present time in most countries of the world are widely implemented the use of unmanned aerial vehicles (UAV) remote sensing due to their low cost, efficiency and versatility. The use of UAV to effectively perform various tasks aerial observation and environmental monitoring and weather conditions, with the possibility of subsequent processing and analysis of aerial photography. Unmanned aircraft over the past few years has been actively used for aerial photography and video recording portions of the earth's surface. The relevance of the study of this work confirmed by the increasing demand for UAV data for mapping purposes. The objective prerequisites for the successful implementation of the present work are the general trends in the development of remote sensing (RS) technology. It's a RS system with using UAV, allowing to obtain high-resolution images (up to 10cm per pixel). This characteristic allows with high accuracy solve various problems of operational monitoring condition of territorial complexes. This project aims at selection of the best software for processing data from UAV from the existing software to date. Present work examines how to choose the most appropriate software from three different

manufacturers by processing the test data taken with a digital camera with an UAV.Restrictions on use in the work only three software due to the limited amount of time to complete the project, difficulties of processing in some software, as well as the limited duration of the work trial versions of software. All software used in the project is commercial and has a limited work period in the trial versions. As the test site was taken photos the territory of artificial lake "Sairan" with an area of 0.6 km2 in Almaty, Kazakhstan(example of UAV photos - Figure 1). In this area there is a height difference of around 30 meters necessary for analysis and comparison. As a result of processing the UAV data, we get a DEM and orthophoto, suitable later for various purposes (Figure 2). Based on the analysis and

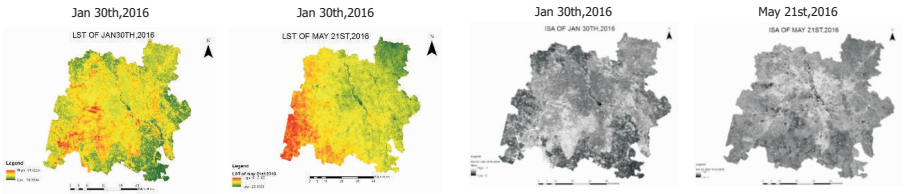


comparison of these data, we conclude - what software is best for working with data from the UAV. The present study thus, demonstrates the methodology for selecting the best software for processing UAV data.

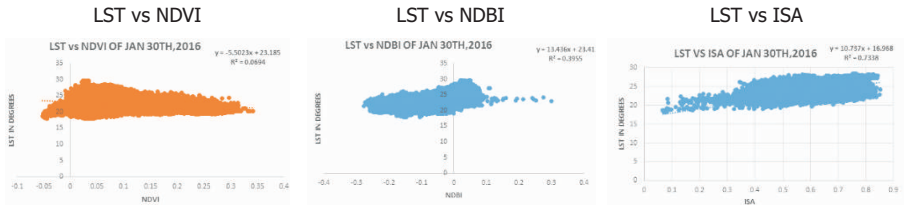
Investigating Impervious Surface Area, Ndbi and Ndvi as Indicators for Urban Heat Island Effect Using Landsat Imagery-a Case Study of Delhi

With the exponential rate of urbanisation, the city is experiencing a shift in its climate. The city which had a cool climate is now facing an increase in its average temperature. This study aims to identify the urban heat islands within the Delhi (NCT) and its surroundings. The study area consists of Delhi, Ghaziabad, Dadri, Noida, Gurgaon and Faridabad. Normalized difference vegetation index (NDVI) has been used as indicator to study the surface urban heat island (SUHI) effects. But their seasonal variation and non-linear relationship with LST suggest that it alone may not be a sufficient metric to study SUHI effects. Recently researchers across the globe have started to study SUHI and its relationship with urbanisation. Since then studies are conducted on the use of normalised difference index as an indicator of LST. Recent studies and researches consider percentage impervious surface as a measure to investigate the phenomenon of SUHI. This study compares the normalized difference vegetation index (NDVI), normalized difference built-up index (NDBI) and the fraction of impervious surface area as indicators of surface urban heat island effects in Landsat imagery by studying their relationship to Land Surface Temperature (LST). Landsat 8 data were used to estimate the LST using Radiative transfer algorithm for two seasons for the Delhi NCR region. A map of impervious surface area was generated using normalized spectral mixture analysis (NSMA). NDVI and NDBI maps were generated for the study area and the correlations between NDVI, NDBI and fraction of impervious surface area and LST were studied. From the study, it was found that a strong linear relationship exists between LST and impervious surface area (ISA) for both the seasons in February and May, whereas the relationship between LST and NDVI was the weakest.

LAND SURFCAE TEMPERATURE(LST) **IMPERVIOUS SURFACE AREA(ISA)**



CORRELATION OF LST WITH NDVI, NDBI AND ISA OF JAN 30TH,2016



Analysis of Urban Green Spaces in Dehradun; Using Remote Sensing and GIS

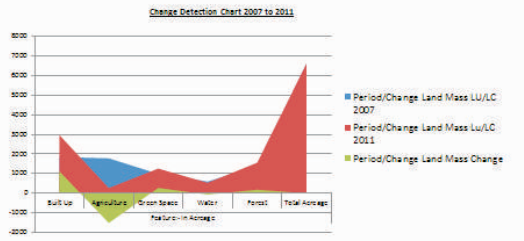
Importance of Urban Green Space (UGS) is well known for maintaining the environmental quality and that they play an important role in physical, social and mental development. These areas function as a visual screen and act as noise barriers and avoid too much spatial uniformity (Dole, 1989). UGS constitute parks, gardens and recreation venue, informal green spaces such as rivers or sea fronts, green spaces surrounding historical sites, railway corridors and indigenous vegetation types.

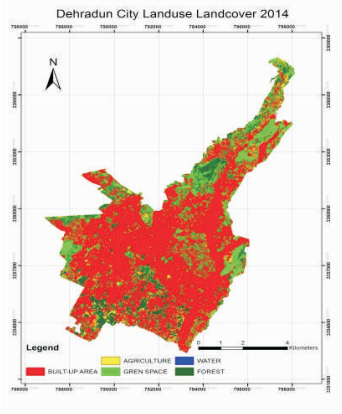
Zeng and Wu (2005) stated that fragmentation of urban green spaces reduces the health of urbanized ecosystems (cited in Tian et al. 2011). In a similar manner, to conserve urban biodiversity in a sustainable way, a common emphasis of spatial planning is to establish a comprehensive urban green space network (Hostetler et al. 2011).

Mapping and monitoring of urban

CHANGE DETECTION RESULTS FOR THE PERIOD 2007 TO 2011

Feature:- In Acreage		Built Up	Agriculture	Green Space	Water	Forest	Total Acreage
Period/Change Land Mass	LU/LC 2007	1852.5222	1787.6666	991.8206	604.0074	1379.502	6615.5188
	Lu/LC 2011	2972.028	273.6752	1267.2324	338.5174	1564.0658	
	Change	1119.5058	-1513.9914	275.4118	-65.49	184.5638	





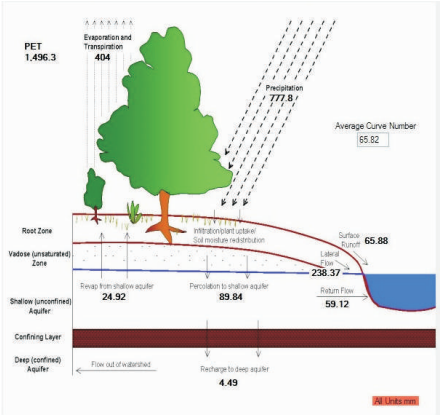
green spaces is a prerequisite for sustainable management and urban living environment. Rapid growth of settlements and consequential ecological problems in urban zones necessitates application of advanced technologies like Remote Sensing; to obtain detailed, current and accurate information about Landuse/land cover (LU/LC) status for management and planning of urban growth.

This paper attempts to investigate the LU/LC changes in Dehradun city and associated changes in urban green cover over the periods from 2007, 2011 and 2014. IRS P6 (LISS-IV) datasets of years 2007, 2011 and 2014 have been used. LU/LC of these years has been delineated using Maximum likelihood supervised technique. Normalized Difference Vegetation Index [NDVI] has been employed for change detection and quantification of decline or increase in urban greenery. Results reveal that over the period of seven years a significant decline has occurred over a short span of time in the urban green spaces of Dehradun city.

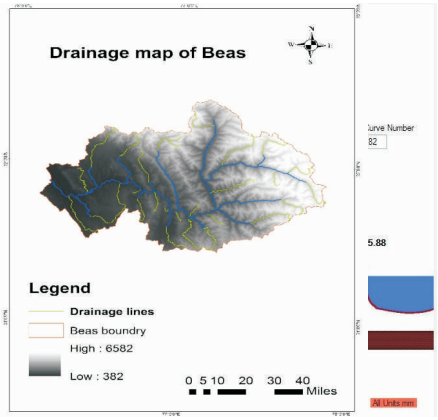
Sediment yield and reservoir sedimentation assessment using geospatial techniques

In this study, Soil and Water assessment (SWAT) model is being used for evaluating sediment yield of a Beas Basin up to Pong reservoir. A set of factors such as land cover, soil, and topography as identified in the SWAT model were studied & reviewed. Each factor which consists of a set of logically related geographic features and attributes, which will be used as data input for analysis. The factor layers are collected from existing literature and data is extracted from ASTER DEM, LULC maps (ISRO-GBP LULC project) and soil texture as well as soil parameters (NBSSLUP). Each of the above mentioned SWAT input parameters, with associated attributed data, will be digitally encoded in GIS database to eventually create input thematic layers for SWAT model. This work further enumerates, SWAT model development in geospatial framework, sediment routing with pixel base soil erosion model to estimate actual sediment yield in Beas river basin. The national centers for environmental prediction (NCEP) climate forecast system reanalysis (CFSR) data of 36-year period of 1979 through 2014 on

following parameters downloaded at daily time interval were used to force the SWAT model. The SWAT model generates almost all water balance components, however, in the present study, discharge and sediment yield at outlet has been studied in detail. Observed discharge data from Bhakra Beas Management Board for period 2001-2012 were used to calibrate and validate model. The Satellite Remote Sensing (SRS) method for assessment of reservoir sedimentation uses the fact, that the water spread area of reservoir at various elevations keeps on decreasing due to sedimentation.



Drainage map of Beas Basin



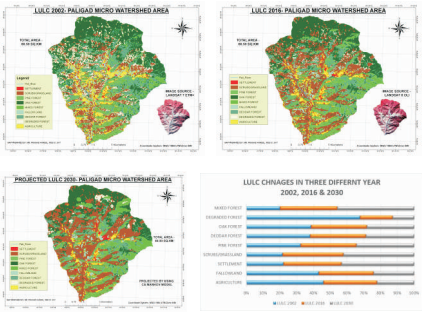
Water Balance

Remote Sensing technique gives us directly the water spread area of the reservoir at a particular elevation on the date of pass of the satellite. This helps us to estimate sedimentation over a period of time. This work describes assessment of sedimentation carried out for the Pong Reservoir using Remote Sensing satellite imageries.

Forest EcosystemServices Assessment by using Geospatial Approaches in Pali Gad Micro-Watershed Area of Garhwal region of Uttarakhand states, India

An ecosystem is a dynamic complex of plant, animal, and microorganism communities and the nonliving environment, interacting as a functional unit. Humans constitute an integral part of ecosystems and impact the ecosystem services obtained from them. Ecosystem services represents both tangible and intangible benefits provided by the environment for sustaining and fulfilling human needs. The objective of the study is to map the ecosystem services viz. carbon sequestration, fuelwood and fodder, emanating from the forests in the Paligad micro-watershed of Tehri district in Uttarakhand state of India. The forest of two time periods are mapped using moderate resolution satellite images of LANDSAT ETM+ (2002) and OLI (2016). Future LULC was predicted by using CA-MARKOV model.

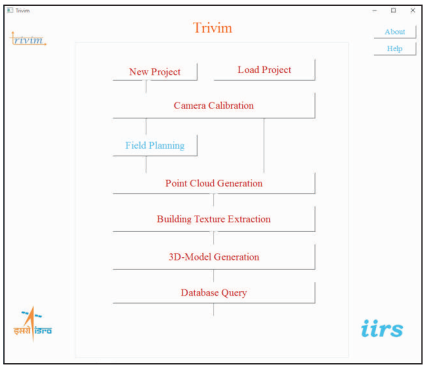
Additionally, InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs) Model was used for mapping carbon sequestration using the LULC maps as input along with the biomass measurements from the field data. For mapping the ecosystem services of the fuelwood and fodder, the forest type maps were complemented with the socio-economic data and the distribution of the fuelwood and fodder providing species based on abundance maps in the GIS domain. Finally an integrated output was generated showing the multiple ecosystem service map of the forests in the study area. This research assumes to be useful for all stakeholders and organization working on the watershed, forestry



and livelihood improvement sector of the Pali Gad region. The major outputs of this research are: 1) LULC map for year 2002, 2016 and 2030 2) Change detection between year 2002 and 2016 2) carbon sequestration as well as economic valuation of carbon map for present year 3) Fodder and fuelwood abundancies and ecosystem service map, 5) Multiple Ecosystem Service representing their economic vale Map.

Application of 3D Database in Estimation of Flood Inundation Area using Trivim

According to UN, flood is one of the most dangerous natural disasters. Between 1995 and 2015, floods affected 2.3 billion people (56% of all affected by weather-related disasters). A period of heavy rain also causes flooding in several states of India every year. Due to different reasons (global warming as well) such events started to happen even in the countries, where it was not a common issue. In 2016 Kazakhstan also experienced widespread flooding in the central part of the country. The main objective of the present study is to estimate the flood inundation area around Ram Jhula Bridge across river Ganga in Rishikesh using Trivim software. Trivim is open source freeware application enables generation of 3D street scenarios using a set of 2D images based on the principles of close range photogrammetry). The application comprises of a series steps which generates a photo textured 3D model that can be exported for 3D visualization in an earth explorer such as Google Earth, Bing 3D, ISRO Bhuvan 3D. Testing and debugging the latest version of Trivim software, which is under R&D at Indian Institute of Remote Sensing, is also part of the work besides the estimation of flood inundation area. The flood inundation area was estimated by using DEM, 3D-model generated by Trivim and map of the area. To get the best result various DEMs, such as ASTER, SRTM and different versions of Cartosat-1 were utilized. The optimum DEM for the area and purpose of study was chosen Cartosat-1 version 3 DEM with horizontal resolution 30 m and vertical resolution 4 m.



Main menu of the last version of Trivim

Project Abstracts of 10th Post Graduate Course in Space and Atmospheric Science

1. Study of the middle and upper atmosphere during Sudden Stratospheric Warming (SSW) episodes
2. Enhancing spectroscopic sensitivity of the CZT Imager onboard AstroSat
3. Source apportionment of black carbon aerosols using Aethalometer
4. Remote sensing of aerosol properties by using sun-photometer
5. Study of Characteristics of Proton Flares associated with CME's
6. Study of interplanetary and geomagnetic signatures of halo CMEs observed during 2011
7. Looking at the coronal loops dynamics using 1-D numerical simulations
8. A study of Stealth CMEs and associated ICMEs
9. CCD photometry of Active Galactic Nuclei (AGN)
10. Ozone and its precursors in Ahmedabad: Features of diurnal and day-to-day variation
11. Investigation of Atmospheric Greenhouse Gases over India
12. Temperature and soil moisture change over Ulaanbaatar, Mongolia

Study of the middle and upper atmosphere during Sudden Stratospheric Warming (SSW) episodes

The Earth's atmosphere is variable in nature due to various dynamical processes in the different layers (i.e. Troposphere, Stratosphere, Mesosphere, and Thermosphere) of the atmosphere. These layers are coupled to each other with the different dynamical, electrical, radiative and chemical processes. A large-scale thermodynamical phenomenon in winter polar regions which affects the middle atmosphere vigorously is Sudden Stratospheric Warming (SSW). Such kind of event development can be ascribed to the growth of PWs propagating upward and their nonlinear interaction with the zonal mean flow.[1] These SSW events have a significant impact on the middle and upper atmospheric dynamics over different regions such as polar region, high, mid and low latitude region. Dynamical coupling through latitude is due to various types of waves and oscillations in the atmosphere. Such interaction causes deceleration and/or reversal of the eastward winter winds and induces a downward circulation in the stratosphere causing adiabatic heating and an upward circulation in the mesosphere resulting in adiabatic cooling. The vertically propagating waves from the lower atmosphere can cause remarkable variations in the ionosphere. Some of the recent observations show that there is an effective connection between SSWs and distinct changes in the ionosphere. But the process responsible for generating variations in the ionosphere in connection with SSW have still been poorly understood. Two major SSW events occurred during 1998-1999; one in December 1998 which is associated with vortex displacement and another in February- March 1999 associated with vortex splitting. Lidar study of these two major events from Mt. Abu (24.36^{0}N, 72.45^{0}E, ~1670 m amsl) has shown that though SSWs are mostly observed over high and mid-latitudes, their effects can also be seen over India also. We have studied ionospheric variations (primarily f_oF_2, h'F and hpF_2) over Ahmedabad (23.1^{0}N, 72.58^{0}E) during these events. Ionospheric disturbances have been found after four-five days of peak temperature. An increase (decrease) in f_oF_2 during morning (afternoon) has been noticed which may be in response to the updrift (down drift). h'F and hpF_2 are also noticed to be increased with fluctuations having a clear peak during early morning. Effects are stronger during Displacement event (1998) than during the Splitting event (1999). Since the growth of planetary waves are responsible for the occurrence of stratospheric warming event, they may have a role in the ionospheric disturbances. In some plots we have noticed semi-diurnal patterns, so we can say that atmospheric tides may also have some role in ionospheric disturbances. We have also studied some recent events occurred during 2006 (January), 2009 (January) and 2013 (January) using temperature data from Sounding of Atmosphere using Broadband Emission Radiometry (SABER) satellite. Though some modeling work supports the hypothesis that Planetary waves are responsible for Atmosphere-ionosphere coupling, there is still more significant works to do to understand how exactly the coupling can take place. For understanding properly we will consider more major and minor SSWs episodes covering different solar epochs along with more stations in different latitudes to see the global picture. Later we will extend this work by studying the role of different types of waves and oscillations which are responsible for coupling between middle and upper atmosphere.

Enhancing spectroscopic sensitivity of the CZT Imager onboard AstroSat

The CZT (Cadmium Zinc Telluride) Imager onboard India's first dedicated Astronomy satellite, AstroSat, is a Hard X-ray imaging & spectroscopic instrument, operating in the energy range of 20-200 KeV. Coded Aperture Mask (CAM) technique is employed here. CZTI count rate is background dominated. Also, the individual pixel response varies over a range of energies. This inherent quality of the

detector pixels is always reflected in any observations. The Detector Plane Histogram (DPH) is the plot that gives us information about the pixel-by-pixel distribution of counts over a range of energies. Hence, to credibly extract the signal (especially in case of fainter sources); it is necessary to have the proper calibration of background. The modulations in DPH for all quadrants over different energy ranges for different observations have been studied. A code was written in IDL for reading the files and computing DPH's. Each of these DPH's was saved to a 4-dimensional array comprising of 4 quadrants and 25 energy bins (each of 10 keV energy). To facilitate direct comparison of DPH's between multiple observations, all the DPH's were divided (quadrant-wise, energy bin-wise) by the total counts respectively. DPH's obtained have been compared with those obtained from the CZTI pipeline and they are in good agreement. The modulations in DPH's over a period of time, for all quadrants, were studied. We will study the distribution of background events in the detector plane in different energy ranges and make modifications in the mask-weighting technique, as required. Further studies are in process to obtain variations in DPH's with longitude and that due to shielding effect due to neighboring payloads. CZTI is a very promising candidate for carrying out Hard X-ray polarimetry above 200 keV. Efforts are on to include polarimetric studies within this project. Thus, with proper knowledge of background, the overall spectroscopic sensitivity of the instrument can be improved upon considerably.

Source apportionment of black carbon aerosols using Aethalometer

Black carbon (BC) particles impact Earth's climate and air quality. Black carbon is a graphitic form of carbon particles with unique physical properties. They also have many negative impacts on human health. Two main sources of black carbon particles in the atmosphere are combustion process involving fossil fuel and biomass burning. The understanding relative contribution of biomass vs. Fossil fuel in atmospheric load of black carbon particles is important for designing effective control policy. During biomass burning several other organic materials are emitted which condense over black carbon particles and change their optical properties. In this pilot study, we explore the difference in optical properties of black carbon particles as a mean to source apportions black carbon particles. Aethalometer is one of the popular instruments worldwide for measuring black carbon particles. Aethalometer measures absorption coefficient at seven discrete wavelengths. Spectral variation of absorption coefficient depends on sources of black carbon particles. Black carbon data is collected using Aethalometer from two different locations: Patiala (30.2° N;76.3° E) an urban location in northern India and Gadanki (13.5° N;79.2° E) a rural location in southern India. The diurnal and daily mean values of BC mass concentration during March 2016 and November 2016 have been determined. Diurnal variation in BC is marked with two peaks, one in the morning hours and other in the late evening hours. The contribution of fossil fuel and biomass burning in absorption coefficient have been determined by assuming exponent value 2.0 and 1.0 of wavelength for biomass aerosol and fossil fuel black carbon respectively. It was noticed that biomass burning activity contributes more black carbon particles over Patiala than over Gadanki.

Remote sensing of aerosol properties by using sun-photometer

Atmospheric aerosol plays an important role in global and regional climate. Aerosols affect our weather and climate because they change the amount of sunlight reaching earth's surface. Aerosol Optical Depth (AOD) is a measurement of transparency (or lack of it) of the atmosphere due to the aerosol. Larger the AOD at given wavelength, less the light of that wavelength reaches earth's surface. Spectral variation of AOD is important for estimating the concentration, size distribution and other aerosol properties in the atmosphere. AOD is

measured at five optical channels by Microtops II sunphotometer at Physical Research Laboratory, Ahmedabad from 30 January to 21 March 2017. The Angstrom exponent 'α' is calculated from AOD measurements. The variation of AOD and α is analyzed on daily basis. Records with 'α' less than 0.5 are removed from further processing as this could be due to the cloud in the field of view of sun-photometer. For remaining data, It is observed that the minimum and maximum of daily average values of α are 0.535 and 1.314 in 17 march 2017 and 15 Feb.2017. Likewise, the value of AOD at 500 nm is 0.183 on 9 Feb. 2017 and 0.902 on 13 Feb. 2017. The value of α shows that the different types of aerosols are present over Ahmedabad in the beginning of the measurement period and in the ending of the measurement period.

Study of Characteristics of Proton Flares associated with CME's

We study 13 flares associated CME and SEP events. Our investigation is two-fold objectives: first we probe the temporal relationship between flares and CMEs within cadence of observations, and next, we focus on the CME dynamics and associated SEP. We employ observations from GOES for X-ray emission from flares as well as protons emitted in association to the flare-CME event. The CME data has been considered from LASCO/ SOHO mission.. We study the temporal characteristics of the flare in 0.5 to 4 Å and 1 to 8 Å. The data is of 3s cadence. Employing this data and CME data we attempt to find temporal correlations. The cadence of CME observations is 12 min and thus correlation is restricted to this time limit. Nevertheless, we find correlation ~0.95 in all 13 events. We have also studied the proton flare characteristic start time, peak time, end time and proton flux in different seven channels viz 0.8-4.0 MeV, 4.0-9.0 MeV, 9.0-15.0 MeV, 15.0-40.0 MeV, 40.0-80.0 MeV, 80.0-165 MeV and 165.0-500.0 MeV. We made spectra from temporal observations in each energy band. We consider 3-hour interval to form the spectra in view of count statistics. The spectra for each proton flare event are fitted with least chi-square method. The spectral index (negative power-law index) is derived at every 3-hour interval for a given event. We then study the growth of spectral index over time of the proton flare event to understand the acceleration process. We found that acceleration process continues for about 20 hours. On the other hand, the CME velocity as a function of integrated proton flux over the rise time enables as to conclude that CME produces the shock and the shock further accelerates the particles with a correlation coefficient of ~0.77. The shock speed depends on the CME dynamics.

Study of interplanetary and geomagnetic signatures of halo CMEs observed during 2011

The effects of solar storms like solar flare, coronal mass ejection (CME), solar bursts etc. have been found to have major effects on the terrestrial magnetic field. We report on the properties of halo coronal mass ejections observed during 2011 using LASCO coronagraphs aboard SOHO spacecraft. Their interplanetary signature recorded by in-situ spacecraft viz, Wind/ACE and STEREO have been examined using measurements at L1, STA and STB (from 3 different viewpoints) and their impact in producing moderate & strong geomagnetic activity have been studied. We have chosen 7 events which are full halo (angular width 360^0) except one which is partial halo (angular width $120^0 \leq W < 360^0$) to study the ICME properties of halo CMEs. ICMEs on 11^{th} March, 6^{th} August, 10^{th} September, 17^{th} September, 24^{th} September, 26^{th} September and 25^{th} October have been studied using the in-situ plasma and magnetic parameters to investigate whether it is Earth directed and produced strong geomagnetic activity or not. Among all 7 ICMEs, 6 were Earth-directed observed at L1 and either in STA or ST. Out of 7 events, 1 was not Earth-directed (ICME on 24th September) but it was observed in STA and STB. Our analysis shows that in situ properties measured at L1, STA and STB for the same ICME are distinctly different which implies that ICME plasma is inhomogeneous. The measured ICME speeds are different in different directions, therefore arrival time of ICME should be estimated using propagation speed in the direction of the spacecraft.

Looking at the coronal loops dynamics using 1-D numerical simulations

Million degree solar atmosphere above relatively cooler (~6000K) surface is an astrophysical enigma. It is understood that the magnetic field is responsible to carry energy from within the sun to its atmosphere, but understanding the mechanism is one of the prominent research in solar physics. Solar active regions are most important in this regard as they show various complicated magnetic behavior. The main ingredients of these active regions are coronal loops. Plasma in these loops is hot and dynamic. Due to high magnetic field plasma is bound to follow the magnetic field lines. We model a coronal loop using one-dimensional hydrodynamic equations. We see the evolution of the loop in space and time when is hit by a nano flare like a heating event. Our result shows, the heat of nanoflare quickly gets conducted to the chromosphere beneath and evaporate plasma in the corona, this mechanism is known as chromospheric evaporation. Such evaporation makes the loop over dense which is seen in the associated figure where we show density evolution in the loop top region. Such phenomenon is consistently observed in coronal loop systems. Such modeled coronal loop data can be folded through the instrument response function to produce intensity like observables and can be compared with the direct observation.

A study of Stealth CMEs and associated ICMEs

Coronal Mass Ejection (CME) is a large eruption of plasma and magnetic field from the sun into interplanetary space. CMEs are most frequently associated with a variety of phenomena occurring in the lower corona before, during the and after the onset of the eruption. CMEs are visible in coronagraph observation, so-called Stealth CMEs do not obviously exhibit any of the low-coronal signatures like solar flares, flows, jets, coronal dimming's or brightening's, filament eruptions or the formation of flare loop arcades like Low Coronal Signatures (LCS). ICME is the heliospheric counterpart of a CME. In this study, Stealth CMEs and associated ICMEs events selected using LASCO/SOHO CME catalog and Cactus catalog are studied. STEREO, ACE, WIND data are selected for selected Stealth CME events. In particular, five events of ICMEs associated with the Stealth CMEs are studied here. Among which 3 of the events arrived at the L1 point and produced a strong geomagnetic storm of ~100 nT or more. None of these events showed any Low Coronal Signatures (LCS). The remaining two events were not Earth-directed and were observed in STEREO S/C. From the analysis of in-situ parameters, we also found that 3rd June 2008 CME arrived at the STEREO B spacecraft, however, if it would have arrived at the Earth, then it would have led to a moderate to the strong geomagnetic storm. Solar eruption without any LCS can lead to unexpected space weather impacts since many early warning signs for the same activity are not present in these events. Our study also shows that although ICMEs associated with Stealth events are associated with minor shocks they can sometimes lead to strong geomagnetic storms. The present study will improve our understanding of Stealth CMEs and the associated ICMEs.

CCD photometry of Active Galactic Nuclei (AGN

Active Galactic Nuclei (AGNs) are the most energetic sources in the Universe. These are the central regions of the host galaxy. Many of them have nearly a stellar shape on photographic plates but cannot be explained by stellar theories. They emit a huge amount of radiation, which is variable, thousand times more than the host galaxy at all the frequencies. Their continuum and emission-line properties manifest

one extreme form of Seyfert activity. NLS1 galaxies may hold important clues to the key parameters that drive nuclear activity. Their high accretion rates, close to the Eddington rate, provide new insight into accretion physics, their low black hole masses and perhaps young ages allow us to address issues of black hole growth, and their optical Fe II emission places strong constraints on Fe II and perhaps metal formation models and physical conditions in these emission-line clouds. In this present work, I have provided a short review of the properties of Narrow-line Seyfert-1 (NLS1) galaxies in the long-term and short-term variability across the electromagnetic spectrum to explain them. Variability studies have been essential in understanding the physics of Active Galactic Nuclei. AGN emit a continuum radiation coming from the vicinity of the black hole. They also emit intense and broad emission lines originating in fast-moving gas clouds located in a small region around the continuum source, known as the broad line region or BLR. The flux level of the continuum and the intensity of the spectral emission lines emitted by AGN undergo variations on time scales ranging from hours to years depending on the energy range and on the intrinsic luminosity of the AGN. When the flux emitted by a source of energy varies significantly with a time scale t this flux variation sets a limit to the size R of the emitting region such that R <=ct. To study the properties of Narrow-line Seyfert1 {Observations of one particular object (B2 1111+32)} galaxies in the long-term and short-term (optical variability) we are using CCD observations from Mount Abu IR Observatory (MIRO) with a 1.2-meter telescope. Three stars in the same images are used as comparison or reference stars to study the nature of variability of the source. As this field is not studied in detail before, more stars are taken as a reference to study the stability of the reference stars also. Their brightness is similar to that of the source. The small variability (scatter in the light curves) seen in the comparison stars is due to photon noise in these rather faint sources. Marginal variability is inferred in one night data. We are processing data of the other nights to estimate the degree of variability present (or not) in the source. There is an indication of a trend in long-term observation (for several months), but we need denser sampling to confirm it. Variability study is also expected to provide us insight on the nature of radio-loudness of this source.

Ozone and its precursors in Ahmedabad: Features of diurnal and day-to-day variation

Air quality and climate change are very challenging problems for all over the world mainly due to increasing emissions from anthropogenic sources. The increased levels of trace gases (for example O_3, CO and NO_x) is a major cause of concern and from local to global scale. The large emissions of trace gases from a variety of anthropogenic sources are one of the major environmental issues in urban and industrial regions. Tropospheric O_3 is the third most important greenhouse gas after CO_2 and CH_4due to the global positive radiative forcing of about 0.39 W m^{-2}as it absorbs earth's outgoing radiation at 9.6 µm wavelength (IPCC, 2007). Surface/ ground level O_3 has two main sources, namely, stratosphere intrusion (Lefohn et al., 2011) and in-situ production via photochemical oxidation of precursor's gases such as CO, CH_4 and volatile organic compounds (VOCs) in the presence of NOx (Sahu et al., 2016). In addition to the greenhouse effect, the higher levels of O_3 at surface adversely affects human health, ecosystem, and crop productivity. Ozone is a precursor of hydroxyl radical (OH) which controls the oxidizing capacity of the troposphere. However, depending on region to region, local emission, meteorological condition and long-range transport play important roles in the variation of O_3 and its precursors. We were interested to investigate the very recent measurements of O_3 and other trace gases. The major goal of my study is to investigate the detailed features of variations and role of key factors controlling the variations of trace gases at this site. We studied the relation between trace gases and including meteorological parameters during a winter month (December 2016 – February 2017) at an urban site of Ahmedabad. The high levels of O_3 during the afternoon hours could be due to enhanced photochemical production and intrusion of air from the free troposphere. In the winter month, the ozone concentration begins to increase after sunrise. The primary peak (evening) and secondary peak (morning) coincide with rush hour

traffic in the city. Winter month, the lowest mixing ratios of CO (NO_x) were observed during the afternoon hours. The mixing ratios of CO and NOx decreased with the increase in wind speed due to the dispersion of pollutants emitted from local sources. The mixing ratio of O_3 increased with the increasing wind speed, suggesting higher levels of O_3 in the upwind region. The rapid decline of O_3 with an increase in relative humidity is due to the chemical loss of O_3.

Investigation of Atmospheric Greenhouse Gases over India

The atmosphere of Earth is composed of several different gases in different concentrations. The major gases whose percentages do not change from day to day are nitrogen, oxygen, and argon. Nitrogen accounts for 78% of the atmosphere, oxygen 20.8%, and argon 0.9%. Minor gases like carbon dioxide (CO_2), methane (CH_4), water vapor (H_2O), nitrous oxide (N_2O) and ozone (O_3) etc are trace gases that account for about a one-tenth percent of the atmosphere. Water vapor is unique in that its concentration varies from 0-4% of the atmosphere depending on location and time of the day it is. Ozone is a pollutant and also responsible for the greenhouse effect. Greenhouse gases (GHGs) and other trace gases play a vital role in controlling the climate system of the lower atmosphere (Stocker et al. 2013). Climate change arising due to the increase in GHGs such as CO_2, CH_4,O_3, N_2O and H_2O etc.in the atmosphere since the pre-industrial times has emerged as a serious global environmental issue and poses a threat and challenge to all of us. The 40% increase in the CO2 from 280 ppm in 1750 to 400 ppm in 2015. Atmospheric CH4 was at 1803.20 ppb in 2011, an increase of 150% from the ambient concentrations prior to 1750.CO2 and CH4 are the most influential anthropogenic GHGs, which together contribute to 80% of the total anthropogenic radiative forcing, leading to global warming (Forster et al. 2007). Without greenhouse gases, the average temperature of Earth's surface would be about −18 ° C rather than the present average of about 15 °C.

In the present project we have investigated the behavior and visibilities of CO2 & CH4 over Punjab, Hyderabad, Assam & Ahmedabad regions from North, South, East& Western regions of India respectively using SCIAMACHY (Scanning Imaging Absorption spectro meter for Atmospheric Cartography) satellite data. SCIAMACHY was one of ten instruments aboard of ESA's Environmental Satellite (ENVISAT). ENVISAT's mission started on March 2002 and was ended in May 2012. CO2 (ppm) -The Carbon dioxide column-averaged dry air mole fraction (XCO2) and CH4 (ppb) - Methane column-averaged dry air mole fraction (XCH4) has been selected from the satellite. Temporal, annual and seasonal climatology variations of CO2 &CH4 has been analyzed from the year 2003 to 2011 and results are found satisfactory (Ref: Sreenivas et. Al. 2016). Examination of CO2 & CH4 data with climate indicators LULC demonstrated an inverse & direct relationship between the LULC w.r.t CO2& CH4 (Ref: Sreenivas et. Al. 2016).

The final observations from the present project are as follows:

1. CO2& CH4 has increased 1.9ppm& 5ppb per annum respectively. The increased concentrations are 375 to 390 ppm& 1760 to 1800 ppb during the year 2003 to 2011 respectively over India.
2. The high CO2 concentrations are observed in Hyderabad and Punjab regions during Pre-moon & Post-monsoon respectively. Whereas comparatively less concentrations observed in North East. And Indian average is falling in between Hyderabad and North East.

Punjab and North East regions have been observed high concentration's during post monsoon.

Temperature and soil moisture change over Ulaanbaatar, Mongolia

Research indicates that natural causes do not explain most observed warming, especially warming since the mid-20th century. Rather, it is extremely likely that human activities have been the dominant cause of that changing. Global air temperatures increased by 0.99^{o}C per century over the past 150 years. Global climate change is already affecting Mongolia and the annual air temperature has increased by approximately 1.6°C (2.6°C/century) in the past 60 years (1940-2000) with warming starting in the 1970s and intensifying at the end of the 1980s (Batima, P. & Dagvadorj, D. (eds) (2000) Climate Change and Its Impacts in Mongolia). The objective is to determine the effect of global warming in Mongolia including Ulaanbaatar.This change can be seen in changes in the atmospheric parameters such as temperature, and geophysical parameters such as soil moisture. In this study, the data collected in the last 50 years in 4 stations in Ulaanbaatar, Mongolia, namely Ulaanbaatar, Buyant-ukhaa, Mongolia national university and Terelj, which are governed by different environmental conditions, will be used. In this project, these data will be analyzed to document the changes in air temperature, soil temperature over Ulaanbaatar, Mongolia. Air temperature and soil temperature are increased respectively 0.6-2.4 ^{0}C and 0.9-2.3 ^{0}C in the Ulaanbaatar, Mongolia. More warming observed month is in July. The temperature increase is attributed to global warming. In recent years, human activities including construction and increased population migration and traffic also big causes of increasing temperature. These changes have affected the environment, water supply, and natural disasters leading to financial, environmental and human loss.

Project Abstracts of 10th Satellite Meteorology & Global Climate

1. Determination of ABL height and global characterization using GPS-Radio occultation data
2. Validation of IASI and INSAT-3D Temperature and Humidity Profiles using Collocated profiles from Radiosonde observations
3. Assessment of Rainfall from INSAT-3D IMSRA Technique for The Flood Event in Malaysia
4. Simulation of Inter-annual Variability of Summer Monsoon Rainfall in a GCM over India and Nepal
5. Estimation and Validation of Total Precipitable Water from MHS over Central Asia
6. Analysis of Mesoscale Convective Systems Using Satellite Data
7. Impact of assimilation of upper air observations on extreme weather events forecast over Indian region
8. Evaluation of atmospheric profiles of ECMWF analysis, GFS analysis and forecast using radiosonde observations over Mongolian region
9. Estimation of Tropical Cyclone Structure using Satellite Observations
10. Study of Variation of Satellite Derived Surface Currents Over North Indian Ocean
11. Satellite Image based Nowcasting of Convective Systems
12. Estimation of Ice Surface Velocity Using Landsat -8 Data Over Inylchek Glacier
13. Assimilation of Satellite retrieved winds in WRF model

Determination of ABL height and global characterization using GPS-Radio occultation data

An algorithm to determine Atmospheric Boundary Layer (ABL) height is established using the radio occultation refractivity data. The algorithm is based on quantitative estimation of the significant lapse of refractivity within the height range of 0.5 km to 5 km. It is known that the ABL is the region of significant lapse of humidity and temperature and is critical determinant of flux of energy and moisture in the troposphere and for air pollution meteorology. Whereas the humidity shows a sharp decrease inside the ABL region, temperature is found to show increasing trend, also called the inversion. Since radio refractivity derived from radio occultation technique is related to temperature and water vapour partial pressure, more dominantly on the water vapour content in the lower troposphere where ABL is normally found, there is a high probability of detecting the ABL signature in the refractivity profile. Refractivity from COSMIC radio occultation is uniformly interpolated at 5 m vertical height and linear regression is applied in the sliding window of width 300 m. The height at which the change in slope of the straight line fit is maximum in the consecutive windows is the top of the detected ABL. Additionally, ABL height is also estimated by finding the maximum of the gradient of the refractivity between 0.5-5 km. Standard deviation of the difference of ABL height from the two methods is in the range of 236 270 m for the COSMIC data for all the seasons- DJF, MAM, JJA and SON. The coefficient of determination, r2 and the standard deviation have the best value of 0.84 and 236 m, respectively. Both the methods work exceptionally well for the high resolution radio occultation derived refractivity profile. The result is compared with collocated radiosonde by applying the algorithm on interpolated radiosonde derived refractivity in the similar way, as well as with the ABL detected using the sharp lapse of mixing ratio in the radiosonde data for the 14 stations. The results are shown for a small collocation match of 23 cases (after outlier removal) yielding r2 of 0.6 and standard deviation of 372 m. The methods were applied on the radiosonde observations collected for the entire year 2011. After outlier removal, a total of 331 and 363 ABL cases were detected for Delhi and Minamidaitojima, respectively and have been used in the statistics. The minimum and maximum range of r2 (standard deviation) are 0.96 and 0.99 (98 m and 217 m). The results emphasize that with sufficiently high resolution of radiosonde observations, the N-grad SW and N-grad methods are suited for ABL determination from refractivity modeled from radiosonde observations. However, an important observation is that the detected ABLs are mostly over marine surface than over land as seen in the global distribution of ABL height.

Validation of IASI and INSAT-3D Temperature and Humidity Profiles using Collocated profiles from Radiosonde observations

Atmospheric temperature and water vapor in air plays an important role in many global weather phenomena like thunderstorms, cyclonic storms etc. Hence, accurate information of temperature and moisture profiles is a critical factor for prediction of such phenomena.

In this study, we have taken Radiosonde temperature and moisture profiles (Mar-2016, February 2017) and collocated with 0.50lat/lon in space and 3 hours in time with IASI observations over Mongolia and INSAT-3D Observations from India. Unlike IASI, INSAT-3D is a geostationary satellite, hence it has a high temporal resolution and its data is available on an hourly basis but only on Indian subcontinent. So, we have maintained temporal collocation of 1 hour with INSAT-3D. While since IASI is a polar orbiting satellite it covers entire globe including Mongolia but only at certain specific times, so to increase number of radiosonde collocations with IASI, we have relaxed our criteria of temporal collocation up to 3 hours. At present, Mongolia have only 4 radiosonde stations.

In this study, bias and root mean

square error are computed along with time series of collocated profiles at various pressure levels. Similarly, all this analysis was done for individual Mongolian radiosonde station. Seasonal variation in error statistics is also have done for 4 major Mongolian seasons. (Spring, Summer, Autumn, Winter).

Assessment of Rainfall from INSAT-3D IMSRA Technique for The Flood Event in Malaysia

Rainfall estimation over tropical region requires continuous measurements in order to understand the pattern and its distribution. The rainfall estimation from satellite is becoming of major interest now as the ground based observation stations are very limited and very less to contribute both in regional to global scale. The rainfall estimation is very important for the national disaster mitigation agencies as firsth and information for planning purposes and it improves our understanding about hydrological cycle in tropics. INSAT Multispectral Rainfall Algorithm (IMSRA) is a new technique developed by SAC-ISRO (Gairola et al. 2015) to quantitatively estimate the rainfall over the Indian land and oceanic regions. The algorithm was developed based on the calibration of Thermal-IR radiances with TRMM-PR Microwave measured rainfall data for retrieval. The same technique is applied beyond the Indian regions to assess the model accuracy and performance. Malaysia is located slightly off from Indian region but within the INSAT-3D satellite observation domain. Extreme rainfall event in Malaysia from 13th to 25th December 2014 is chosen and evaluated for the study. Thermal IR from INSAT-3D satellite data is used for rainfall estimation and validated with TRMM-3B42 and GSMaP dataset. The IMSRA estimated rainfall is also merged with the surface rainfall obtained from 34 observation stations in Malaysia on daily basis. The statistical result showed strong positive correlations between merged IMSRA, TRMM-3B42 and GSMaP and ground based measurements. The finer spatial resolution of INSAT-3D data is another advantage that will allow algorithm to estimate and generate finer rainfall distribution map by using Geographical Information System (GIS). Thus, quantitative rainfall over any smaller region of interest is estimated and the overall result shows strong evidence that the IMSRA technique has performed very well in Malaysian regions as well.

Simulation of Inter-annual Variability of Summer Monsoon Rainfall in a GCM over India and Nepal

Monsoon is one of the major phenomenon over the entire tropical belt that is associated with the regional climate primarily through rainfall. The importance of the monsoon rainfall is prolonged to a large fraction of the world's population and the socio economic prospect of the region. Almost two thirds of humanity live within regions influenced by monsoon. Thus the prediction of the monsoon rainfall well in advance assumes great significance. The present study aims to measure the skill of the state-of-art AGCM in simulation of ISM rainfall and to investigate the inter-annual variation using the climatological and observed SST. Community Atmosphere Model (CAM) (v4, 0.47°×0.63°) developed by NCAR has been used for this study. Two experiments have been conducted; viz. CLIMO Exp. using climatological SST and OBSST Exp. using observed monthly OI-SST.

The climatology of surface temperature, wind circulation and rainfall over the extended Indian monsoon (60°E110° E;0°N40°N) region has been generated through 30year long-term simulation of CAM and analyzed using different observed Climatology viz. TRMM rainfall, NCEP reanalysis, IPCC, UD generated climatology, IMD & DHM in-situ observations etc. The model derived monthly averaged surface temperature climatology over the study region has a good correlation with the observed NCEP climatology. Both the simulations are able to capture the sea surface temperature over the Indian Ocean and over the landmass. The model simulation shows heat sink region over the western part of India and spreads over the eastern part almost

reaching Bay of Bengal region and gets slowly reduced after approaching the south west monsoon rains. The seasonal temperature variation over the study region, monthly mean, maximum and minimum are comparable. The climatological wind circulation at 850 hPa and 200 hPa are well simulated. The reversal of wind during pre-monsoon and monsoon season over the region are nicely simulated by both the experiments.

Analysis revealed that the model simulated rainfall is affected by systematic bias. Both the simulations after rain-bias correction are able to capture the large scale features of observed climatology. The OBSST Exp. shows better agreement with seasonal rainfall variability of summer monsoon. However, the orographic rainfall near the Foothills of Himalayas, Western Ghats is wells imulated but affected by overestimations. Further, the long term continuous simulations are able to show the reasonable amount of inter-annual variation over the region. Therefore, this study using high resolution modeled data provides an insight of the model credibility in capturing the climatic variability over the region (India, Nepal and its surroundings) and its capability for predicting the inter-annual variation and projecting the climate of the globe.

Estimation and Validation of Total Precipitable Water from MHS over Central Asia

Water Vapour in the atmosphere is vital for global weather and climate. The accurate temporal and spatial measurement of humidity is possible today by satellite observations. Satellite passive microwave observations around the 183.311 GHz water-vapour line can provide accurate monitoring of water-vapour profiles, with good temporal and spatial sampling for operational numerical weather prediction (NWP). The MetOp satellite carries two passive microwave sounders, Microwave Humidity Sounding (MHS) and Advanced Microwave Sounding Unit-A. MHS provides water vapor measurements in the 183.31±1, 183.31±3 and 190.311 GHz, plus the two window channels at 89 and 150 GHz at 16 km spatial resolution. In this project, we have estimated Total Precipitable Water over Central Asia using MHS observations and TPW data from the six-hourly operational global analyses (European Centre for Medium Range Forecasting) and did comparison of Retrieved TPW with Radiosonde data. The retrieval is performed using linear regression and Neural Network (NN) model by using collocated MHS and ECMWF data for training. The Multi-Layer Perceptron NN technique resulted in marginally better error characteristics compared to the linear regression technique with the root mean square errors (RMSE) ~25% higher than the errors reported by NOAA for their operational retrievals. Also, stratifying the retrieval method based on local zenith angle had negligible effect on the result. The validation of these retrieval schemes is performed using radiosonde observations over Central Asia. Statistics of comparison of Retrieved TPW with Radiosonde data shows that the error are rising during the humid season in the summer (6.71 mm), maximum during rainy season (7.42 mm), and falling during the dry winter season (4.8 mm). Also the errors are larger in the northern stations during the summer season and smaller during the winter season.

Analysis of Mesoscale Convective Systems 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 Bangladesh region

(20.450 28.400 N and 88.050 92.400 E) for the duration of two months (March, April and May of 2016 for which in-situ reports of convection were available over the study region) using stability indices from satellite data. For this a number of MCSs were identified and analyzed to understand their evolution. Different types of stability indices and some suitable dynamical parameters were selected based on the environmental conditions. Threshold values of these stability indices were set for these systems which give a clear indication of convective development.

Impact of assimilation of upper air observations on extreme weather events forecast over Indian region

India is a Tropical country which is surrounded by Himalayas to north and Indian Ocean to south. Because of its topographical variability, it experiences diverse climatic conditions and undoubtedly this makes it recognised as Indian Subcontinent. India is affected by both extra-tropical as well as tropical weather systems. At times when both these systems are present as well as they interact with each other, it leads to severe weather activity like heavy rainfall over the region. There have been few flood events over the Indian region in the past five years, especially during south west monsoon. These disasters have taken many lives to toll and assets to irreparable loss, two of such cases are unforgettable, Uttarakhand (2013) and Jammu & Kashmir (2014). Numerical Weather Prediction (NWP) models have been able to predict these events in the past; however accurate spatial and temporal prediction of rainfall is still a challenge.

This study attempts to assimilate upper air observations (Radio Sonde and Pilot Balloon) in Weather Research Forecast (WRF) Model using three dimensional Variational (3DVar) technique and study its impact on predicting severe weather events over Indian region. Total five cases have been studied, one each over J&K and Uttarakhand and three over Central Indian region. WRF model has been set to nested domain with outer domain of resolution 30 km and inner domain of 10 km. Model was set to 'WSM-3' Microphysics, 'Yonsei University' Planetary Boundary Layer and 'Kain-Fritsch' Cumulus Parameterization scheme. Two model runs were performed, one CNT (without assimilation) and another EXP (with assimilation). Results revealed that the Root Mean Square Difference and Bias for 'OBSERVATION-ANALYSIS' was lesser than 'OBSERVATION BACKGROUND', which suggested that analysis was closer to observations.

ECMWF ERA interim data was used to compute the 'Improvement Parameter' for Analysis and Forecast for state Variables (Temp and Specific Humidity) while JAXA GSMAP rainfall data was utilised to verify the impact on rainfall.

There was an improvement of an order of 30% in the state variables (Temp and Specific Humidity) in Analysis as well as in 24 and 48 hours forecast. Same magnitude improvement was also visible in 24 hours but slightly lesser in 48 hours predicted rainfall in EXP. Domain area with positive, negative and neutral impact was studied. It was found that after assimilation 50-60% area in the domain experienced positive impact while 20-30% area had negative and around 20% area was neutral i.e. no impact in almost all five cases.

Evaluation of atmospheric profiles of ECMWF analysis, GFS analysis and forecast using radiosonde observations over Mongolian region

Mongolian economy is primarily governed by agriculture and livestock, therefore, weather plays a very important role in Mongolian economy. Over the past 20 years, among the disasters, strong wind and storm are the most reported events in Mongolia. However, severe convective disasters related to mesoscale weather process occurred frequently over the past 10 years such as squall, hail, lightning and flash flood. Strong wind and strong storm accounted for 36% of total occurring disasters, while flash flood and lightning are 16-19% respectively, squall is 13% and hail is 7%. It is worth mentioning here that

approximately 2.4 million livestock were lost in bad weather or natural disaster in the year 2000, which resulted in fall of gross domestic product (GDP) from 3.2% to 1.3%. An accurate weather forecast can not only save lives of human but of extremely valuable livestock too. For providing weather forecasts over whole Mongolian more atmospheric profiles are needed over this region. This requirement can be fulfilled by taking observations from satellites or from global numerical weather prediction (NWP) models. NWP models are extensively used for predicting the future state of the atmosphere. Particularly, in recently years, the improved weather forecasting skills of NWP. As it is well known that quality of weather forecast depends on the data used for forecasting, therefore, it is desired to evaluate atmospheric profiles from a given source before using it for forecasting purpose. This study is primarily undertaken to evaluate the accuracies of atmospheric profiles of temperature, dew point temperature, humidity, wind-speed and wind-direction from ECMWF analysis, GFS analysis and forecast. The main advantage of using global NWP model based atmospheric profiles for weather forecasting is that NWP model output is freely available at each grid point and on regular time interval. This study is evaluating ECMWF analysis, GFS analysis and forecast profiles by validating it with RAOBS of four stations.

Estimation of Tropical Cyclone Structure using Satellite Observations

The accurate estimation of structural parameter of tropical cyclones viz., center, size, strength etc. are highly important as they are used as input in various cyclone prediction models. The satellite observations play an important role in the estimation of these parameters. In the present study, high resolution wind products (12.5 km) obtained from QuikSCAT satellite, during the period 2000-2009 have been analysed for estimating the structural parameter of cyclones formed in the North Indian Ocean which includes Bay of Bengal (BOB) and Arabian sea (ARB) region. The Joint Typhoon warning Centre (JTWC) best track data records of cyclone formed in the North Indian Ocean (NIO) has been analysed to estimate the statistics of tropical cyclone characteristics.

The size of TC has been estimated by computing the azimuthally averaged radial distance of the contour of 12 ms-1 wind speed around the cyclone center. The high resolution wind product of QuikSCAT satellite over the tropical cyclones formed during the study period were analysed and TC size were estimated. The values of size of TCs were compared to the size based on radius of outermost closed isobar (ROCI) which is operationally given by Joint Typhoon Warning Centre (JTWC). The sizes of cyclones formed in the BOB region and ARB regions were also compared. The results show that the cyclones formed in the BOB region are larger in the size than the ARB region. The strength of TCs formed in the BOB and ARB were also estimated and their correlation with TC intensity was analysed.

As a case study the structure of tropical cyclone VARDAH (07-12 Dec,2016) has been studied using the currently active satellite data viz., SCATSAT-1 and INSAT-3D. The high resolution wind products of SCATSAT-1 over the cyclone VARDAH were used to estimate the size of tropical cyclone, its radial wind profiles. The different channels data of INSAT-3D was used to understand the structure of cyclone observed by the clouds and its relationship w.r.t. surface wind observations.

Study of Variation of Satellite Derived Surface Currents Over North Indian Ocean

An ocean current is a continuous, directed movement of seawater generated by forces acting upon this mean flow, such as sea level gradient, associated breaking waves, winds, the Coriolis effectand sinking of water due to temperature and salinity differences. Ocean surface current is a dynamic parameter, the global and regional cycle and variability of which is difficult to capture from in-situ

measurements. The advent of Satellites for measuring various atmospheric and ocean phenomenon is being utilized to measure the currents by observing sea level through Altimeter derived gridded Map of Absolute Dynamic Topography (MADT) generated from the suite of altimeters such as JASON-2, SARAL/ALTIKA, Cryosat etc., wind stress derived from scatterometers such as ERS-1,2, QuikSCAT and ASCAT wind data and SST data derived from AVHRR. The methodology uses the combination of the geostrophic component from altimeter data and the ageostrophic component from scatterometer and radiometer data (Bonjean and Lagerloef, (2002)). The surface currents thus derived are made available for the period from 1 Jan 1993 to 31 Dec 2016 over the Indian Ocean region (from SAC) for the present study. The surface currents data variability represented to 15m depth and corresponding Eddy Kinetic Energy(EKE) and Mean Kinetic Energy (MKE) are critically analyzed. Variation of magnitude of zonal and meridional components over specific regions viz. SE Bay of Bengal, Head Bay, Coastal Tamil Nadu (to capture EICC), Konkan-Kerala Coast (to capture WICC) and Somali coast (to capture Somali current) are analyzed. The scope of the discussion also undertakes inter-comparison of above mentioned satellite derived currents with Modular Ocean Model (MOM) generated analysis current (used by Navy) and RAMA Buoy observed currents at few locations in the Indian Ocean Region. One of the vital variability that have been captured includes, reduction of peak strength of EICC during November since 2006. Such cycles are discussed in relation with other events such as variation monsoonal shifts, Nino Index variation and Dipole mode index variability. The discussion concludes on the aspect of importance in continuity in utilization of satellite derived surface currents and how it would help in understanding long period cycles and local changes in the vast ocean.

Satellite Image based Nowcasting of Convective Systems

The observation and prediction of spatio-temporal structures in a Satellite Image Time Series is an integral element in satellite based weather nowcasting. Satellite observed thermal infrared (TIR) image sequence provides valuable insight into the vertical evolution of convective systems. Low Brightness Temperature (BT) values represent high cloud cells and marked increase in number of contiguous pixels having cold BT values indicate development of deep convective zones. 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 INSAT-3D and INSAT-3DR 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 Thailand region for convective systems case studies for the year 2016. 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. It is also observed that by using combined 15 minutes INSAT-3D and INSAT-3DR observations, the error in predicting the size of the system is reduced considerably, especially during the dissipating stages.

Estimation of ICE Surface Velocity Using Landsat -8 Data Over Inylchek Glacier

Glaciers, especially in mountain area are sensitive indicators of climate fluctuations. The study of glacier velocity is important to study mass balance of ice, glacier dynamics and predict glacier hazards. In Central Asia the glaciers are the primary resource for fresh water. Understanding the seasonal behavior of these glaciers would help to make efficient use of the available water reservoir. This article presents results of a study carried out to estimate ice surface velocity of the Inylchek glacier, Tien Shan range of in Kyrgyzstan. The availability of the high quality spectral bands of the Operational Land Imager (OLI) on board Landsat-8, the data allows us continuous monitoring of Earth's surface changes including geological processes, climate change and anthropicchange. Surface changes related to displacement of the Earths Surfaces like Sand Dune migration, glaciers migration, co-seismic ground deformation landslides can be measured using automatic ortho-rectification, co-registration and sub pixel correlation of satellite data available in COSI-Corr (Co-registration of Optically Sensed Images and Correlation) Software package. The displacement vector is deduced by applying sub-pixel image correlation technique on the temporal Landsat-8time series datasets (2014-2016-2017). Although, the Landsat-8 OLI data was terrain corrected geo-referenced images, we carried our accuracy assessment before subjecting them to COSI-Corr. We found that the relative geometric accuracy of the dataset was very good. The Digital Numbers (DN) values were converted to radiance and surface reflectance. The spatio-temporal variations were analyzed. Displacement vectors were obtained in EW and NS directions along with SNR using COSI-Corr.

Assimilation of Satellite retrieved winds in WRF model

AMVs) were assimilated into the Weather Research and Forecasting (WRF) model using three-dimensional variational (3D-Var) data assimilation method. The objective of this work is to compare the importance of wind vectors assimilation (traditional method; ASSI_UV) against wind speed and direction assimilation (new method; ASSI_SD). Three parallel set of experiments are performed using with and without assimilation of atmospheric motion vectors (AMVs) in the cyclic mode. In addition to Indian geostationary satellite INSAT-3D retrieved AMVs, microwave radiances from the Advanced Microwave Sounding Unit-A (AMSU-A) and Global Positioning System Radio Occultation (GPSRO) refractivity data are also assimilated in all the experiments. Results show that assimilation of INSAT-3D AMVs improve model analyses and subsequent forecasts compared to without AMVs assimilation experiments (No AMVs). Further, results show that assimilation of speed and direction (ASSI_SD) directly improve bias in analyses compared to ASSI_UV experiments. It is important to note that ASSI_SD run has positive impact on temperature and moisture predictions compared to ASSI_UV run which is due to multi-variate nature of variational data assimilation.

Meeting of CSSTEAP Governing Board

The 22nd meeting of CSSTEAP Governing Board (GB) was held at Bengaluru on November 15, 2017. The meeting was chaired by Mr. A.S Kiran Kumar, Chairman CSSTEAP GB and Secretary, Department of Space, Govt. of India and was participated by all the GB member and invited participants. The GB members included Dr. Thomas Djamaluddin, Indonesia, Mr. Hari Odari, Nepal, H.E. Dato Hidayat Abdul Hamid, Malaysia, H.E. (Mrs.) Ma. Teresita C.Daza, Eng. Mr. S. Panawennage, Sri Lanka (through Skype), Ms. Kamani Ediriweera, Representative of Sri Lanka, Dr. Simonetta Di Pippo (UNOOSA), Mr. Hojjat Mousazadeh, Iran, Prof. A. A. Abdykalykovich, Kyrgyzstan; Dr. Ammarin Pimnoo, Thailand and Dr. A. Senthil Kumar participated in the 22nd GB Meeting. Other participants included Dr. Shirish Ravan (UNOOSA), Mr. Chris Dewanto (Indonesia), Mr. Noordin Ahmed (Malaysia), Dr. Y.V.N Krishna Murthy, Dr. Anil Bhardwaj, Shri Shantanu Bhatawdekar, Mrs. Shankari Murali, Dr. Sarnam Singh, Dr. D. Gowrisankar,Dr. S.P. Aggarwal, Dr. Baby Simon,Dr. J. Banerji, Dr. P. Murugan, Dr. Arijit Roy, Dr. K.R. Manjunath, Dr. P.K. Pal, Dr. S.K. Srivastav, Mr. C.M. Bhatt, Dr. Harish Karnatak and Sri Rajender Katariya from India.

Dr. A. Senthil Kumar, Director, CSSTEAP welcomed the members and special invitees to the 22nd meeting of the CSSTEAP-GB. He mentioned that CSSTEAP is performing extremely well and established itself as a Centre of excellence with the support and guidance from GB members.

Shri A.S. Kiran Kumar, Chairman, CSSTEAP-GB welcomed all the GB members, observers and special invitees to the GB meeting. He expressed his satisfaction on the commendable growth of the Centre in all spheres of activities related to capacity building in Asia Pacific region, under the able guidance of learned GB members. He expressed his extreme gratification that the Centre has completed 22nd glorious years of commendable service of capacity building in Asia Pacific region. The chairman also commended the center for the different short and long term courses in the different fields of space sciences.

Chairman, CSSTEAP-GB informed members that based on the recommendation of UNOOSA in last GB meeting, a special course on Post Disaster (Earthquake) Rapid Damage Assessment was jointly organized by CSSTEAP, UN-HABITAT and UNSPIDER at Myanmar, in which 44 participants from different departments of Myanmar participated. He emphasized that, while the activities of CSSTEAP are steadily growing in terms of scope, quality and number of courses, there is always a scope to further improve the participation from Asia and the Pacific region. He urged all the honorable members to sponsor senior managers and technocrats to these courses to accrue the benefits of space science and technology in the region. Chairman, CSSTEAP-GB expressed his gratitude to GB members for all their whole hearted support to CSSTEAP and looking forward for their continued cooperation and guidance in future as well.

Dr. Simonetta Di Pippo, Director, United Nations Office for Outer Space Affairs expressed her pleasure to address the Governing Board and acknowledged the participation of all governing board members in the 22nd Meeting of the Governing Board. She expressed that CSSTEAP is part of family of six Regional Centres affiliated to the United Nations offering the best possible programmes, opportunities and experiences in space education, research & applications to students around the world. She highlighted that UNOOSA attaches great importance to these regional centres, as they have a unique role in imparting capacities to officials and students in developing countries. The role played by CSSTEAP and other centres in this regard is a valuable contribution to UNOOSA's mandate of capacity-building and is of great relevance, when we deal with an important component of UNISPACE+50, namely thematic priority 7 Capacity-building for 21st century. She appreciated the CSSTEAP's Post Graduate Diploma Programmes in the core disciplines of Remote Sensing and Geographic Information Systems, Satellite Communications, Satellite Meteorology & Global Climate, and Space and Atmospheric Sciences. Dr. Pippo was also pleased to note that, in 2017, CSSTEAP responded to UNOOSA request to engage in some of the initiatives organized by United Nations Platform for Space-based Information for Disaster Management & Emergency Response (UN-SPIDER). She thanked Shri A.S. Kiran Kumar, Chairman, ISRO and Chair of the Governing Board, for providing the financial, human resources and infrastructural support for running the activities of CSSTEAP.

Chairman, CSSTEAP-GB and Director, UNOOSA inaugurated Knowledge portal which is inbuilt in CSSTEAP website and educational dashboard -SWAMI (System for Weather and Aapdaa Management Information). These were appreciated by all GB members as informative and interactive.

Dr. A Senthil Kumar, Director, CSSTEAP presented report highlighting programmes, activities, host country support, etc. and reiterated that Centre would be involved in capacity building in space science & technology and applications in five assigned areas and also special theme-based short courses. He also apprised the dignitaries about the successful completion of 21st RS&GIS, 10th SATMET, 10th SAS PG Courses and Short courses on various themes.

Director, CSSTEAP mentioned about his participation in Meeting of the Directors of all Regional Centres for Space Science and Technology Education (CSSTE) during June 13-14, 2017 at Vienna on Capacity Building for 21st Century. Also, CSSTEAP participation in Technical Advisory Mission for Disaster Management under UN-SPIDER framework at Nepal during July 31-Aug 4, 2017. CSSSTEAP Expert presented the use of Space Technology in DM Support/DRR in Himalayan context. Dr. A. Senthil Kumar presented planned activities in 2018 and mentioned that PG courses planned are: 23rd RS&GIS, 11th SATMET & SAS Courses and 7th Short course on Small Satellite Missions and two theme specific short courses namely Geospatial Modelling in forestry & Ecology for climate change response studies and Disaster Risk Reduction. Director, CSSTEAP apprised about the future plans to continue the present P.G. Diploma & short courses in disciplines on space science technology & applications and to continue support M.Tech. research scholarship and need based for PhD. Research on a specific request from AP countries. He also emphasized that EDUSAT like distance education programmes should be taken up by CSSTEAP and GB member countries.

Dr. Shirish Ravan, UNOOSA has suggested that CSSTEAP should organize an outreach programme of about 2 hours at New Delhi for GB Members, Non-GB Members, and embassy officials at the time of announcement of courses.

The meeting was closed by Chairman, CSSTEAP-GB who thanked all the GB members for their active participation and involvement in improving the overall activities of CSSTEAP. He mentioned that CSSTEAP is doing excellent service in Asia-Pacific region and all the countries are actively participating and sending their scholars / professionals/ students.

Dr. K. Sivan takes over as Chairman ISRO

Dr. K Sivan joined ISRO in 1982 and was inducted into PSLV Project. He is specialised in Aerospace engineering, Space Transportation Systems Engineering, Launch vehicle and mission design, control & guidance design and mission simulation software design, Mission synthesis, simulation, analysis and validation of flight systems.

He has significantly contributed towards end-to-end mission planning, design, integration and analysis. His innovative contributions, particularly the strategies adopted in mission design enabled the consistent performance of PSLV. This has also proved to be a good foundation for other launch vehicles of ISRO, like, GSLV MkII & MkIII including RLV-TD. He is the chief architect of 6D trajectory simulation software, SITARA, which is the backbone of the real-time and non-real-time trajectory simulations of all ISRO launch vehicles. He was responsible for commissioning world-class simulation facility in ISRO for mission synthesis and analysis, which is used for mission design, sub-system level validation and integrated validation of avionics systems in all ISRO launch vehicles. He developed and implemented an innovative 'day-of launch wind biasing strategy' that enables rocket launch on any day, under varied weather and wind conditions. He was the chief mission architect for successful launch of 104 satellites in a single mission of PSLV.

He has received many awards including Doctor of Science (Honoris Causa) from selected universities.

He has numerous publications in various reputed Journals including a book in Nov 2015 "Integrated Design for Space Transportation System" published by Springer.

Support to UN Activities by CSSTEAP

TECHNICAL VISITS/ COOPERATION

Director, CSSTEAP attended meeting of the Directors of all Regional Centres for Space Science and Technology Education (affiliated to the United Nations) during June 13-14, 2017 at Vienna, Austria. The objective of the meeting was to work out for innovative approaches to capacity building in space science, technology, policy under the theme 'Capacity Building for the 21st Century'.

UN-SPIDER sends Technical Advisory Mission teams to the countries in Asia-Pacific region to discuss and make recommendations to develop guidelines for the use of space based information in disaster management. CSSTEAP supported Technical Advisory Mission under UN-SPIDER framework at Nepal during July 31-August 4, 2017. One expert from CSSTEAP was deputed to attend the TAM.

OFF CAMPUS TRAINING SUPPORT

Training at Yangoon, Myanmar

CSSTEAP organized a one week customized training programme for Myanmar Officials on 'Post Disaster (Earthquake) Rapid Damage Assessment" jointly organized by UNOOSA/UN Habitat, Myanmar and CSSTEAP at Yangon, Myanmar during March 28 April 03, 2017. The objective of the course was to impart skills to use integrated earth observation technology for earthquake damage and loss assessment by introducing the basic concepts and methodologies. CSSTEAP provided support in developing training programme and by deputing two experts to Myanmar for this course. The course was attended by 44 participants from 16 related departments.

Training at Beijing, China

On the request of UNOOSA to organize one week (25-31 October, 2017) customized international training programme on "International Training Course on Integration of Multisource Earth Observation Data for Disaster Damage Assessment" for 25 international participants which was organized back to back with 7th UN-SPIDER Conference in Beijing. The training programme jointly organized with the support of the Asia Pacific Space Cooperation Organization, the National Disaster Reduction Centre of China and the Beijing University at RSCSSTEAP with training experts from UN-SPIDER and CSSTEAP. Two experts from CSSTEAP/IIRS were deputed for conducting the training at Beijing.

RECENT LAUNCHES

Earth Observation Satellites

	Launch Date	Launch Mass	Launch Vehicle	Orbit Type
Cartosat-2 Series Satellite	Jan 12, 2018	710 Kg	PSLV-C40/Cartosat-2 Series Satellite Mission	SSPO
Cartosat-2 Series Satellite	Jun 23, 2017	712 kg	PSLV-C38 / Cartosat-2 Series Satellite	SSPO
Cartosat -2 Series Satellite	Feb 15, 2017	714 kg	PSLV-C37 / Cartosat -2 Series Satellite	SSPO

PSLV-C40/Cartosat-2 Series Satellite Mission

India's Polar Satellite Launch Vehicle, in its forty second flight (PSLV-C40), successfully launched the 710 kg Cartosat-2 Series Satellite for earth observation and 30 co-passenger satellites together weighing about 613 kg at lift-off. PSLV-C40 was launched from the First Launch Pad (FLP) of Satish Dhawan Space Centre (SDSC) SHAR, Sriharikota. The co-passenger satellites comprise one Microsatellite and one Nanosatellite from India as well as 3 Microsatellites and 25 Nanosatellites from six countries, namely, Canada, Finland, France, Republic of Korea, UK and USA. The total weight of all the 31 satellites carried onboard PSLV-C40 is about 1323 kg. The 28 International customer satellites were launched as part of the commercial arrangements between Antrix Corporation Limited (Antrix), a Government of India company under Department of Space (DOS), the commercial arm of ISRO and the International customers. PSLV-C40/Cartosat-2 Series Satellite Mission was launched on Friday, Jan 12, 2018 at 09:29 Hrs (IST).

First day Cartosat-2 Series Satellite Multi-spectral Image over part of Indore taken on January 15, 2018. Source: NRSC/ISRO

PSLV-C38 / Cartosat -2 Series Satellite

India's Polar Satellite Launch Vehicle, in its 40th flight (PSLV-C38), launched the 712 kg Cartosat-2 series satellite for earth observation and 30 co-passenger satellites together weighing about 243 kg at lift-off into a 505 km polar Sun Synchronous Orbit (SSO). PSLV-C38 was launched from the First Launch Pad (FLP) of Satish Dhawan Space Centre (SDSC) SHAR, Sriharikota. This is the seventeenth flight of PSLV in

First day Cartosat-2 Series Satellite Multi-spectral Image of Doha, Qatar taken on June 26, 2017. Source: NRSC/ISRO

'XL' configuration (with the use of solid strap-on motors). The co-passenger satellites comprise 29 Nano satellites from 14 countries namely, Austria, Belgium, Chile, Czech Republic, Finland, France, Germany, Italy, Japan, Latvia, Lithuania, Slovakia, United Kingdom and United States of America as well as one Nano satellite (NIUSAT) from India. The total weight of all these satellites carried on-board PSLV-C38 is about 955 kg. The 29 International customer Nano satellites were launched as part of the commercial arrangements between Antrix Corporation Limited (Antrix), a Government of India company under Department of Space (DOS) and the commercial arm of ISRO and the International customers.PSLV-C38/Cartosat-2 Series Satellite Mission was launched on June 23, 2017 from SDSC SHAR, Sriharikota.

The imagery sent by Cartosat series of satellites will be useful for cartographic applications, urban and rural applications, coastal land use and regulation, utility management like road network monitoring, water distribution, creation of land use maps, change detection to bring out geographical and manmade features and various other Land Information System (LIS) as well as Geographical Information System (GIS) applications.

PSLV-C37 / Cartosat -2 Series Satellite

India's Polar Satellite Launch Vehicle, in its thirty ninth flight (PSLV-C37), launches the 714 kg Cartosat-2 series satellite for earth observation and 103 co-passenger satellites together weighing about 663 kg at lift-off into a 505 km polar Sun Synchronous Orbit (SSO). PSLV-C37 was launched from the First Launch Pad (FLP) of Satish Dhawan Space Centre (SDSC) SHAR, Sriharikota. This was the sixteenth flight of PSLV in 'XL' configuration (with the use of solid strap-on motors). The co-passenger satellites comprised of 101 nano satellites, one each from Kazakhstan, Israel, The Netherlands, Switzerland, United Arab Emirates (UAE) and 96 from United States of America (USA), as well as two Nano satellites from India. The total weight of all these satellites carried on-board PSLV-C37 was about 1377 kg. PSLV-C37 also carried two ISRO Nano satellites (INS-1A and INS-1B), as co-passenger satellites. These two satellites carry a total of four different payloads from Space Applications Centre (SAC) and Laboratory for Electro Optics Systems (LEOS) of ISRO for conducting various experiments. The 101 International customer Nano satellites were launched as part of the commercial arrangements between Antrix Corporation Limited (Antrix), a Government of India company under Department of Space (DOS), the commercial arm of ISRO and the International customers. PSLV-C37/Cartosat-2 Series Satellite was successfully launched on Wednesday, February 15, 2017 at 9:28 Hrs IST from SDSC SHAR, Sriharikota.

Communication Satellites

	Launch Date	Launch Mass	Launch Vehicle
GSAT-17	Jun 29, 2017	3477 kg	Ariane-5 VA-238
GSAT-19	Jun 05, 2017	3136 Kg	GSLV Mk III-D1/GSAT-19 Mission
GSAT-9	May 05, 2017	2230 kg	GSLV-F09 / GSAT-9

GSAT-17

India's latest communication satellite, GSAT-17 was inducted into the INSAT/GSAT system on June 29, 2017 from Kourou, French Guiana by Ariane-5 VA-238. Weighing 3477 kg at lift-off, GSAT-17 carries Payloads in Normal C-band, Extended C-band and S-band to provide various communication services. GSAT-17 also carries equipment for metereological data relay and satellite based search and rescue services being provided by earlier INSAT satellites. GSAT-17 is designed to provide continuity of services on operational satellites in C-band, Extended C-band and S-bands. GSAT-17 was launched into a Geosynchronous Transfer Orbit (GTO) by Ariane-5 VA-238 launch vehicle. After its injection into GTO, ISRO's Master Control Facility (MCF) at Hassan takes control of GSAT-17 and performs the initial orbit raising maneuvers using the Liquid Apogee Motor (LAM) of the satellite, placing it in circular Geostationary Orbit. The designed in-orbit operational life of GSAT-17 is about 15 years.

GSAT-19

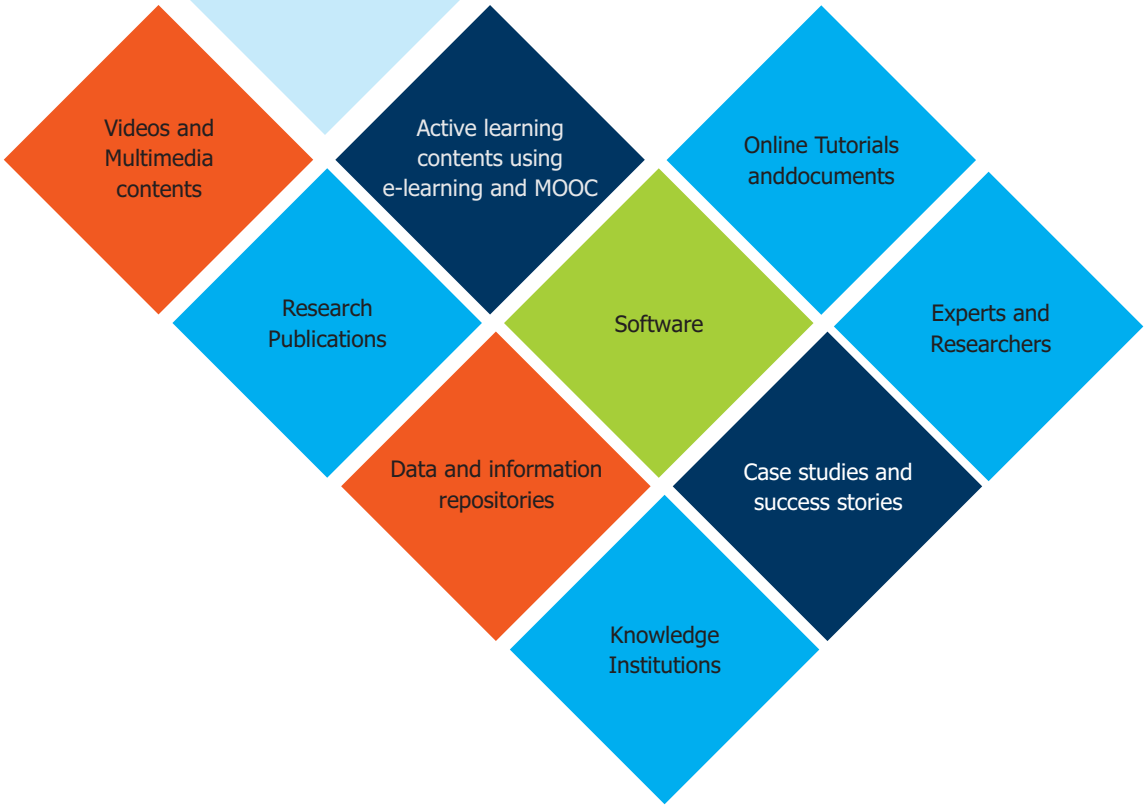
GSAT-19 satellite with a lift-off mass of 3136 kg, is the communication satellite of India, configured around the ISRO's standard I-3K bus. GSAT-19 carries Ka/Ku-band high throughput communication transponders. Besides, it carries a Geostationary Radiation Spectrometer (GRASP) payload to monitor and study the nature of charged particles and the influence of space radiation on satellites and their electronic components. GSAT-19 also features certain advanced spacecraft technologies including miniaturised heat pipe, fibre optic gyro, Micro Electro-Mechanical Systems (MEMS) accelerometer, Ku-band TTC transponder, as well an indigenous Lithium-ion Battery. GSAT-19 satellite was launched by GSLV Mk III-D1 on Monday, June 05, 2017 from the Second Launch Pad (SLP) at Satish Dhawan Space Centre SHAR (SDSC SHAR), Sriharikota.

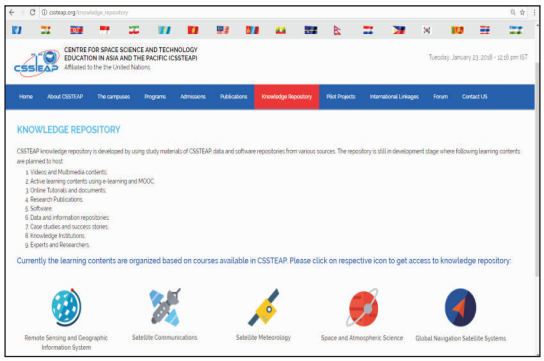
GSAT-9

South Asia Satellite GSAT-9 is a Geostationary Communication satellite realised by India. The primary objective of GSAT-9 is to provide various communication applications in Ku-band with coverage over South Asian countries. GSAT-9 is configured around the ISRO's standard I-2K bus. With lift off mass of 2230 kg the main structure of the satellite is cuboid in shape built around a central cylinder. GSAT-9 carries communication transponders operating in Ku-band. The two solar arrays of GSAT-9 consisting of Ultra Triple Junction solar cells generate about 3500 Watts of electrical power. Sun and Earth sensors as well as gyroscopes provide orientation reference for the satellite. The Attitude and Orbit Control System (AOCS) of the satellite maintains its orientation with the help of momentum wheels, magnetic torquers and thrusters. The satellite's propulsion system consists of a Liquid Apogee Motor (LAM) and chemical thrusters using liquid propellants for initial orbit raising and station keeping. The satellite also carries plasma thrusters, assisting in station keeping. GSAT-9 was launched by GSLV-F09 on Friday, May 05, 2017 from the Second Launch Pad (SLP) at Satish Dhawan Space Centre SHAR (SDSC SHAR), Sriharikota.

CSSTEAP Digital Knowledge Repository

A new initiative of developing a knowledge repository is taken for benefitting CSSTEAP students by using study materials of CSSTEAP, data and software repositories from various sources and providing on the CSSTEAP site. The knowledge repository contains materials for all major Post Graduate Diploma Courses and also on Small Satellite Missions short course. The information can be browsed and content can be searched based on theme, topic, sub-topic, keywords. The repository is still in development stage where following learning contents are planned to host:



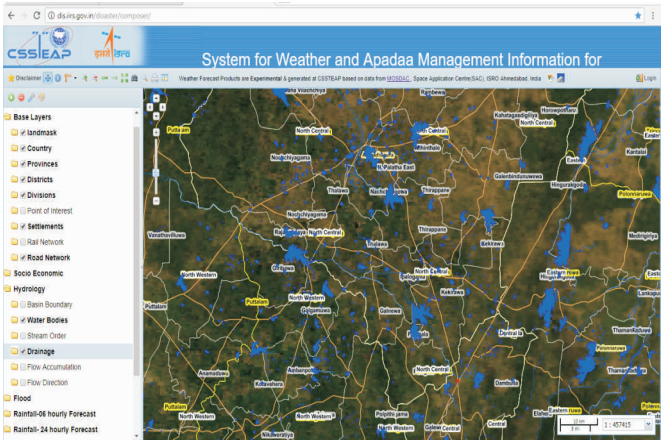


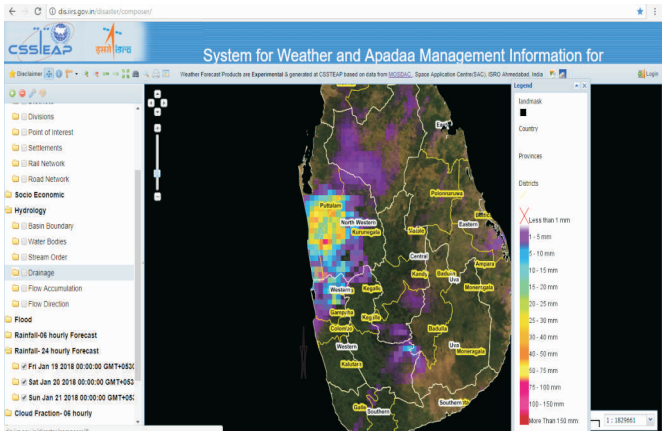
S.No	Theme	Subtheme	Topic	Study Material	Presentation	Topic Order
1	RS&GIS	Water Resources	Watershed characteristics and morphometery of drainage basin			
2	RS&GIS	Water Resources	Hydrology and Physical Processes in Watershed			
3	RS&GIS	Water Resources	Applications of Digital Elevation Models in Water resources			
4	RS&GIS	Water Resources	Erosion, Erodibility & Sediment Yield Modelling			
5	RS&GIS	Water Resources	Quantification of Soil Erosion Using RUSLE			
6	RS&GIS	Water Resources	Watershed conservation planning and Management Strategies			
7	RS&GIS	Water Resources	Economic & Financial Analysis of Water Resources Projects			
8	RS&GIS	Water Resources	Principles of Remote Sensing in Water Resources Assessment			

CSSTEAP Educational Dashboard "SWAMI"

An educational dashboard "SWAMI" (System for Weather and Apadaa Management Information) is developed as a pilot study, for Sri Lanka. Geoportal provides country specific data and information services on base layers (road, rail, settlements, country, district, province, points of interest), socio-economic (population and households), hydrological layers (basin, flow direction, flow accumulation, flood vulnerable areas), hydro-meteorological forecast products (rainfall, temperature, humidity, cloud fraction and wind speed).

The dashboard objective is to provide country specific geo-web services and portal applications pulling from various open sources to the students coming from Asia Pacific region. The CSSTEAP participants from respective countries will work on their own data and services. The outcomes of student projects will automatically update and enrich the data repositories, and in future can be utilized by prospective students joining courses to further enhance the study. This framework will be extended for other Asia Pacific countries.





Alumni meet at Yangon, Myanmar and Kathmandu, Nepal

Alumni meet at Yangon, Myanmar

Alumni meet at Kathmandu, Nepal

- An alumni meet with students of CSSTEAP from Myanmar was organized on 31st March 2017 at Yangon, Myanmar. About 26 participants attended the meet.
- An alumni meet with students of CSSTEAP from Nepal was organized on 2nd August 2017 at Kathmandu, Nepal. About 20 participants attended the meet.
- The main outcome of the meeting includes recommendations for short course on DRR, Water Resources and Ground Water, UAV applications, Mapping of heritage sites, SATCOM in disaster management, Latest trends in satellite applications, Image processing forecasting of flood, Advance RS&GIS/ Navigation and Refresher course for alumni.

Glimpses of student activities at CSSTEAP

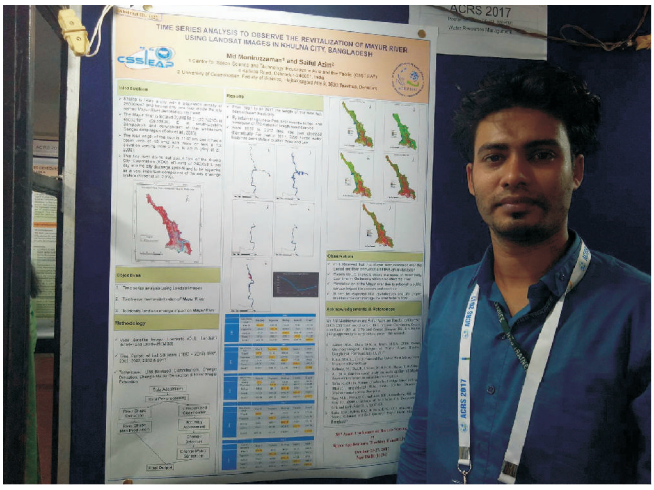
Attending classes

Attending Geoglam_Pre-symposium tutorials

Carrying out photogrammetry practicals

Celebrating Independence Day

Field visit of FED thematic discipline participants



Participating in ACRS, New Delhi

Understanding the antenna operation at IMGEOS, Shadnagar

Field visit of WRD thematic discipline participants

Watching live IRS satellite passes at IMGEOS, Shadnagar

Visit to Indian Institute of Soil and Water Conservation

Visit to Mussorrie

Visit to Ramanaidu film City,Visakhapatnam

Visit to Kailasagiri Park, Visakhapatnam

Visit to India Gate, Delhi

Students participating in cultural programme

Visit to Mussorrie

Visit to Ramoji Film City, Hyderabad

Ongoing Courses

22nd Post Graduate course on Remote Sensing & Geographical Information System (RS&GIS)	9 Months	1st July 2017 to 31st March 2018
11th Post Graduate course on Satellite Communication (SATCOM)	9 Months	1st August 2017 to 30th April 2018
2nd Post Graduate course in Global Navigation Satellite Systems (GNSS)	9 Months	1st August 2017 to 30th April 2018

Future Courses

Geospatial Modelling in Forestry and Ecology for Climate Change Response Studies	2 Weeks	16th April to 27th April 2018
Disaster Risk Reduction (DRR) with Special Emphasis on Floods and Earthquakes	4 Weeks	28th May to 22nd June 2018
Small Satellite Mission	2 Weeks	20th Nov to 1st Dec 2018
23rd RS & GIS PG Course	9 Months	1st July 2018 to 31st March 2019
11th Satellite Meteorology & Global Climate	9 Months	1st August 2018 to 30th April 2019
11th Space & Atmosphere Science	9 Months	1st August 2018 to 30th April 2019
User demand courses	2-4 weeks	TBD

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