

MEMBER COUNTRY: India
National Report to SCAR for year: 2016

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Scientific Research Program						
AAA 1) 2) 3) 4)						
AntEco 1) 2) 3) 4)						
AnT-ERA 1) 2) 3) 4)						
AntClim21 1) 2) 3) 4)						
PAIS 1) 2) 3) 4)						
SERCE 1) 2) 3) 4)						

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SCAGI						
1) 2)						
Other Groups (optional)						
SOOS						

Scientific Highlights for 2015-16

40 projects from 35 different premier institutes / universities of India were taken up during the said period of 2015-16. Brief highlights have been provided under subheads:

Atmospheric & Meteorology

IMD (Bharati) -I Observation of Meteorological Parameters and Ozone

3-hourly recording of meteorological parameters at Bharati in automated mode and delivery to Global Telecommunications System (GTS) was carried out successfully. The record of weather data was transferred in near real-time for analysis and use in weather models to IMD. Also, GPS based Ozone Sonde experiments using Balloon launches were carried out and data was recorded.

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IMD (Bharati) -II Observation of Meteorological Parameter, Solar Radiation and Ozone

Ozone-hole phenomenon over Antarctica and effect of depletion of Ozone on Global climate change are being studied by scientists internationally. Scientific observations from increased no of sites and periodicity and over long-term helps to understand the ozone depletion phenomenon more thoroughly. With the objective to monitor the Ozone depletion status on a long-term basis, Ozone sonde experiments were initiated from Bharati station from the current expedition. As part of this activity, GPS Ozone Sonde & Radio Sonde Antenna & instruments were installed and Balloon launches every 10 days were initiated from Feb 2016.

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NRSC:I Measurements of Atmospheric Black Carbon (BC) and Green House Gases (GHGs) at Antarctica on a Long-Term Basis

Antarctica due to its pristine environment is most suitable for background measurements of Atmospheric Black Carbon and Green House gases. These observations are useful in assessing anthropogenic effect on atmosphere in the main land through comparison of BC and GHGs measurements of Antarctica with that of the Main land. The study through the long term measurements of BC and GHGs in Antarctica aims at understanding the role of long range transport and prevailing meteorology on concentrations of BC and GHGs in Antarctica. Towards estimation of background concentration of CO₂ (GHG) at Bharati Station on a continuous basis for long term period, instrument for observations of atmospheric CO₂ was installed which provides records CO₂ data at 1 sec interval. Measurements of BC concentration in snow were carried out to understand BC deposition over Antarctic region.

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NRSC:II Study of snow melt/freeze dynamics in Antarctica using space based and ground based observations

Study of the melt/freeze behavior of the Antarctica Ice sheet/shelves is essential to understand their response to climate change. Space based Microwave data is being used by researchers to assess the spatial distribution and extent of melt/freeze conditions of different Ice shelves of Antarctica. Ground based information on snow and ice characteristics including melt/freeze status, snow density, temperature, depth, water content are required for calibrating and validating Satellite Data. Ground Penetrating Radar (GPR) survey traverses were carried out besides Snow fork based measurements of snow and ice over frozen sea around Bharati peninsula (Quilty Bay), ThalaFjord and Stake area network in Groveness area during the summer period. The ground truth data will be useful in developing the operational products in cryosphere for Antarctica under NICES programme

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IIG Geophysical studies in Polar regions

Towards Geomagnetic studies, IIG is operating instruments such as (i) Digital Flux Gate Magnetometer (DFM) for recording variation in the three orthogonal components H, D and Z of the earth's magnetic field, (ii) Proton Precession Magnetometer (PPM) for recording the total magnetic field, (iii) Global Position System (GPS) for crustal deformation and atmospheric studies e.g. total electron content, water vapor etc, (iv) Electric Field Mill (EFM) for recording electric field, (v) Automatic Weather Station (AWS) for recording meteorological parameters and used for analysis of GEC studies. During the current expedition Induction coil Magnetometer (ICM) was installed at Bharati for continuous observations on geomagnetic and space weather activity. The instruments including the power systems were monitored and maintained regularly for proper functioning. Besides, the instruments were calibrated periodically towards having accurate measurement of data.

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IITM & ESSO-NCAOR Reactive Trace Gases and their linkages to Marine Biogeochemistry

The MAX-DOAS instrument was installed in the Arora Hut near by the station for continuous open sky observations from the sensor during the summer. The setup was initially trail tested in the Electronics Lab of the station and precautions like Lamp based heating in the hut to maintain the required operating temperature for the systems were taken to make the system function without breakdown. Scattered radiation data recorded by the system in automated mode was regularly downloaded and analyzed. Due to heavy snowfall the instrument was turned off for couple of days, hence no data was recorded.

Concentrations of halogen compounds in atmosphere are found to be above the detection limit of the instrument. Last year, due to measurement in late summer, the concentrations of the halogen compounds were found below the detection limit. The plot show here corresponds to the SCD (slant column density) of oxygen dimer (O_4) in atmosphere on 8th, Dec 2015 (It is being the most sunny day so far). The solid dots represent the concentration above detection limit whereas hollow dots represent below detection limit. The different colour shows measurement at different elevation angles. The instrument has recorded the scattered solar radiation till late summer hence giving insight about the evolution and trend of halogen compounds in atmosphere.

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SPL Climate Change Research and Space Weather Studies

About 27 samples of ambient aerosol were collected using HVS. Besides, 36 balloon launches were conducted for Radiosonde and Ozonesonde experiments (36 radiosondes and 7 ozonesondes) for the measurement of vertical profiles of meteorological parameters viz., Temperature, humidity, wind speed, wind direction and Ozone. Also, Intense Observation Programme (IOP) for the measurements of vertical profiles of meteorological parameters was also carried out through four balloon launches of radiosonde. Repairing work for GPS and CRABEX (Coherent Radio Beacon Experiment) receivers were completed. 16 snow samples were collected at locations near to Bharati station for estimation of deposited BC aerosols on snow. Measurements of greenhouse gases (CO_2 and CH_4), three components of wind, temperature and humidity were carried out using Greenhouse gas analyser and sonic anemometer respectively. For the estimation of total electron content in the Ionosphere, SPL's GPS and CRABEX (Coherent Radio Beacon Experiment) receivers have been operational at Bharati station for last few years. Repairing/Maintenance work for GPS and CRABEX receivers were completed.

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SASE: Temporal and Spatial Variations of Meteorological Parameters Energy Fluxes and study of Ice Sheet Dynamics using Remote Sensing and In Situ Measurements.

Hourly observations of various snow-meteorological parameters (Incoming solar radiation, Outgoing solar radiation, Sun shine duration, Net radiation, Minimum air temperature, Maximum temperature, Average ambient temperature, Relative humidity, Wind speed, Wind direction, Atmospheric pressure, Snow surface temperature, Snow depth) have been taken over the continental ice sheet during the above-mentioned period. Surface energy budget of the glacier is estimated for the above-mentioned period.

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ICSP:Study of Long Path Radio Wave Propagation Characteristics and Theoretical Simulation of Ionospheric Perturbations from Indian Antarctic Station.

Installed one electric field study the variation of mid-latitude and polar Ionospheric parameters by propagation characteristics of Very Low Frequency (VLF) signal behaviors and to observe the variation of cosmic rays in during the voyage and in Bharati and Maitri region.

Installed two 12 feet electric field VLF antenna and fixed one antenna permanently for winter one Ultramsk and one SoftPAL system simultaneously. In parallel the broadband signal are also being recorded by these systems to detect the possible radio atmospherics (Sferics) and Lightning Induced Phenomena.

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SAC:Study of Polar Sea Ice and Ice Shelf Dynamics Using Satellite Data, In-situ Observations and Numerical Models

Aerial Survey : of Disintegration and Dalk Glacier, towards Davis station, Polar Record Glacier towards West Coast of Bharati, of Rifts on Amery Ice Shelf

GPR Measurement: Sea Ice, Ice Sheet and Ice cube cutting , Fast Ice near Bharati Coast, Ice Sheet on Disintegration Glacier and cube cutting , Snow pack region, On the Dalk Glacier, Ice Sheet at Progress Air field, Amery Ice Shelf, India Bay, Iceberg Separated from Lazerav Iceberg, Sankalp, Icewall, Veteheia, Novo Airfield

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NPL & ESSO-NCAOR:Response of sub Auroral Ionosphere to the space weather events.

1 The CADI instrument is working properly viz continuous measurement, recorded data and automatically store in PC on daily basis.

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Real time plot of CADI Different plasma parameters of Ionosphere is being collected and recorded properly and continuously.

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Earth Science – Geology & Glaciology :

GSI: I Glaciological Studies in the Larsemann Hills, East Antarctica for assessing the impact of climate change

As part of the studies, measurements of snow accumulation/ablation in the study network of 25 stakes (250x250 square meter grid) over the Polar Ice Sheet south of Grovnes, Larsemann Hills was carried out and data was recorded. Also, measurements of snow accumulation/ablation in the other study network of 16 stakes (200x200 square meter grid) over the Polar Ice Sheet, south of ALCI runway was carried out and data was recorded. These measurements aid in assessing the impact of climate change in long term.

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GSI: II Relationship between the paragneiss and orthogneiss in the Larsemann Hills, Antarctica

Besides, Geological field work in south Grovnes, Fisher and McLeod is in progress. One set data of DG snout in Schirmacher Oasis was taken before the start of Austral summer 2015. Geological field work in North Grovnes, Manning, and McLeod Islands is in progress. Geological samples for petrographic study, geochronology are taken from aforementioned islands. Geological field work in Manning, Brattnevet, Best, and McLeod Islands is in progress. Geological samples for petrographic study, geochemistry and geochronology are taken from aforementioned islands.

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GSI: III Provenance and depositional environment of lake sediments from Larsemann Hills area and Schirmacher Oasis, East Antarctica vis-a-vis geochemistry, heavy minerals and sedimentology

Two lake sediments cores were taken from McLeod Island for analysis. A sediment corer is being assembled over lake L-3 in Bharati peninsula for obtaining a core from the lake for study. Lake sediments cores are taken from Progress Lake, Broknes Peninsula, South Grovnes and Manning Island. Weekly water sample collection from Lake-3 and onsite determination of parameters viz; pH, EC and Total Solids was carried out. Also, water samples were collected from Lake-1 to Lake-5. Sediment coring in Larsemann Hills area and sub sampling of the cores are completed.

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SOI: Large scale Topographical mapping and Geophysical studies for Neotectonics & Monitoring Inter-plate movement of Antarctica plate with respect to the Indian plate

Under this ongoing programme of developing horizontal & vertical reference frame and large scale mapping for the Larsemann Hills region of Antarctica, SOI team has carried out the surveys after initially establishing equipment & store and conducting recce for the surveys. GPS observation at Bharati station and 9 Ground Control Points (GCPs) in Larsemann Hills (Bharati Station, GCP 01-North Grovnes, GCP 05-Fisher Island, GCP 06-Soloman Island, GCP 07-South Grovnes, GCP 08-Brotrnevet Island etc) for study of Interplate Movement between Indian plate and Antarctica plate were carried out and data was sent to National GPS data centre, Dehra Dun. Towards large scale mapping of Larsemann Hills region, survey field work of Brokenness area (Total area 40sq. Km approx) which was divided into 6 PT was carried out during the current expedition

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Delhi Uni: A proposal for Geological investigations south of Indian Bharati Station to elucidate sub-ice geology and to establish the affinity of western Princes Elizabeth Land (PEL) with appropriate cratonic block

As part of the project scientific activities: (i) Planning of ICECAP-2 flight plans (geological advice), (ii) Preliminary processing of ICECAP-2 data (aero-geophysical data in collaboration with the ICECAP-2 team which stayed at Zhongshan station and (iii) Collection of rock samples and structural data for validation of geophysical inferences were carried out.

Flight operations were conducted with China's new research aircraft *Snow Eagle* (tail number CF-GCX). Flights were operated by Kenn Borek Airlines (KBA) with three-person crew (two pilots and one engineer). A radial survey design was planned to maximize coverage (Fig 1). A total number of 19 survey flights were conducted from 15th December 2015 to 29th January 2016.

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ESSO-NCAOR Hydrodynamics of the Indian Ocean sector of coastal Antarctica

To monitor the geostrophic circulation and transport and its temporal variation across the region between Africa and Antarctica, the expendable probe data (XCTD) were collected throughout Cape Town to (37 degree latitude) to Bharati , Bharati to Maitri and Maitri to Cape Town

The XCTD probe were launched at the every half degree latitude along the cruise track

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NHO- Hydrographic Survey – Off Princess Astrid Coast and Larseman Hills

Recovery of existing stations on Bharati Island and Maitri Set up GPS station at LH Ref, Bharati and Maitri research Station

Delineation of coast including islands within the prescribed survey area

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BSIP-Paleoclimatic studies from Antarctic Coastal Areas (Larsemann Hills and Scirmacher Oasis) based on terrestrial and marine records

Towards sedimentological column based study of paleoclimatic variations in Antarctica, lake-sediment cores were collected in Bharati penininsula and surrounding Islands of the Larsemann hills region during the summer period of the current expedition. As part of the activity, identification of potential sampling sites for the collection of lake and profile sediments was carried out by undertaking traverses to nearby Islands to Bharati. Additionally, water, algal mat, Dry surface sediments, moss and hard rock samples were collected from these sites. Dry Piston Corer Assembly was used for extracting core samples.

All the sediment core samples have been sub-sampled at 2 cm interval in the Earth Science Laboratory at Bharati. Lithology of all the sub-sampled sediment cores have been noted.

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NGRI-Permanent Seismological and GPS observatory at Maitri, Antarctica

Permanent continuous GPS (Global Positioning System) data recording for Crustal Deformation Study in Maitri Station was downloaded and 1. Seismic data was downloaded from Data Acquisition Unit

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Biology & Environmental Sciences

BARC: Measurement of Radiation Level due to Cosmic Rays and Terrestrial Radiation at and around Bharati Station

As part of the long term study of cosmic ray dose at Antarctica, radiation monitoring instruments in and around Bharati Station were operated during summer period of the current expedition. Importantly, two Indian Environmental Radiation Monitoring Network (IERMON) systems were installed successfully. One indoor and another outdoor at the station for recording gamma ray dose rates on a continuous basis and the same were integrated into IERMON network. Both the systems continuously record gamma dose rates. With the help of IT and networking team from NCAOR, auto transfer of the generated data on an hourly basis to BARC routed via NCAOR

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Wildlife Institute of India:Long Term monitoring of Wild life and its habitats in Antarctica and Southern Indian Ocean

Snow petrel nesting activity in the surroundings of Bharati peninsula during summer was monitored daily by installing camera stations near the bird nests. The camera stations were monitored on daily basis for their functioning in Antarctic conditions and maintained for obtaining the recordings (Fig:1). Video-taping for behavior classification analysis was initiated at selected nest sites and daily video-taping was carried out during 24th Dec 2015 – 10th Feb 2016. Microclimate data was recorded using Temperature loggers placed at selected nest sites (n =15). Also, new nests covering Easter, Breadloaf and Betts Islands were marked for monitoring. Biological samples (more than 200 Nos) of Birds were collected from Bharati peninsula, Broknness, FisherMcLeod, Cook, and Easter Islands. Two aerial transects were conducted around Larsemann hills to estimate seal population

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(ESSO-NCAOR & Amity Univ Environmental monitoring and health of Indian Antarctic Stations in pursuit of Antarctica-Treaty System and it's Governance

Objective of the study is to monitor the environment through various indicators in an around Bharati research station. Towards determination of the pollutants in the Antarctic environment system, samples of lake water, sediment and algal mats were collected from various locations including Broknness Peninsula area, Broknness Island, Fischer Island, Sander Cock Island, McLeod Island, Solomon Island, NorthGrovnness and SouthGrovnness areas. Lake water, surface sediment were collected by using composite sampling method. For biological parameters, sterilized bottles (approx.200 ml capacity) and for chemical parameters one litre bottles were used. Surface sediments from different locations were taken in sterilized polybags and sealed. Latitude/Longitude of all locations was recorded along with other environmental conditions. Photographs of lakes and algal mats/blooms and mosses were also taken for further enrichment of scientific data. Watersamples inside Bharati station were also taken. All the samples collected from the field visits were carefully transported and preserved at Bharati station and subsequently packed and shifted to deep freezer of Ship (Ivan Papnin) for further transportation to India. Biological and chemical parameters (Persistent organic pollutants such as PCB, HCB, DDT, HCH etc.) will be analyzed as they are the important group of pollutants which are omnipresent in the environment and some of them are toxic; hence will be determined in the different components of Antarctic environment. A reference list for the collected samples with sample identification number, Latitude/Longitude, location and sample type was prepared. Presentation related to the scientific work was prepared and will be presented in due course of time.

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Human Physiology & Medicine

DIPAS Effect of yogic practices in Antarctica

Temperature near Bharati station, Antarctica is breaking previous records. Wind chill factor exceeding -30 degree Celsius just in March end during the current expedition. In Antarctica such temperatures increase sympathetic activity of human body and remains pre-dominant. Yoga not only increases para-sympathetic tone but also gives overall balance in autonomic function. Preliminary findings under this project using heart rate variability instrument are suggesting maintaining the autonomic balance of members. Cold induced pulmonary vasoconstriction has been reduced especially among regular yoga practitioners as indicated by spirometry. One of the regular yoga members has given feedback that his sinus problem no longer exists due to practice of pranayam during yoga session. It was expected more significant positive changes in lung volumes esp. among yoga practitioners but due to extreme cold which causes pulmonary constriction same not observed. Some yoga members have stopped smoking. Some have reduced alcohol intake or frequency or both. As soon as the ship departed, behavior and attitude of some members changed. Morning yoga session is not only bringing members closer to each other but also they share jokes and compete with each other for more accurate yoga postures bringing positivity and liveliness. They often want to increase duration of yoga session and include more yoga postures.

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