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REPORT SaGAA 2011



National Conference on **SCIENCE & GEO POLITICS OF ARCTIC & ANTARCTIC**

2011

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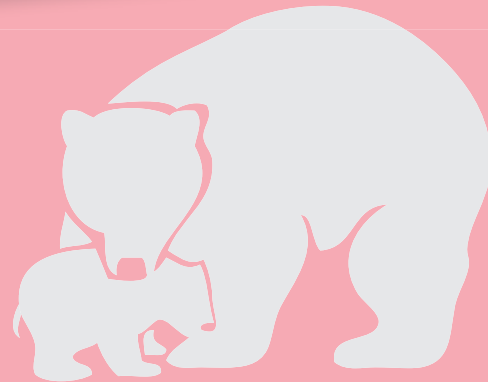
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EMERGING SCIENCE- GEOPOLITICS INTERFACE IN THE POLAR REALMS

India led its first scientific expedition to the Antarctic in 1981 and to the Arctic in 2007. India is thus, among the very few nations in the world to have research interests both in the Arctic and the Antarctic.



The National Conference on Science & Geopolitics of Arctic & Antarctic (SaGAA) held on the 14th and 15th of January 2011 enabled scientific and legal experts from all over the nation present their path breaking research and created a networked group of stakeholders that interacted on a single platform to enable greater amalgamation of global research. The recommendations and views put forward will

be a beacon for developing nations such as India with policy makers using SaGAA 2011 documentations shape future adaptation and exploration programmes. The interdisciplinary role played by the different stakeholders who are parties to the polar dialogue will enthuse a whole new generation with an active interest in research of polar areas – building the scientific capacity of India and the world.



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The opening session of SaGAA, 2011 began with lighting of the ceremonial lamp at the conference hall by the Dr. Shailesh Nayak, Hon'ble Secretary, Ministry of Earth Sciences (MoES) - the Chief Guest. Introducing the key personalities the Convener of the Seminar and President, LIGHTS, Ms. Sulagna Chattopadhyay, invited Dr. P. C. Pandey, Professor, IIT and Chairman of the Organizing Committee to open the Seminar with his speech.

SaGAA 2011 Executive Summary



Arctic and Antarctic are generally regarded as the barometer not only of the world's climatic impact but also of its exploration possibilities. The countries having research stations in the polar realms are considered ahead in scientific temperament and prowess at the same time the possible resources in these regions make the presence of different countries geopolitically important. Therefore, it is important to bring together the Science and Geopolitics of Arctic and Antarctic. The scientific research are being mapped and documented better today than they were even a decade ago. Despite prolific studies, international consensus on critical dialogue that emerges from the fragile icy realms of Arctic and Antarctica still largely fragmented. Although, tropical regions such as India are located far away from the epicenters of the polar areas, yet the ripples of change in the Arctic and Antarctica have far reaching implications for populous resource starved nations such as India. Thus the holding of stakes in Polar Regions needs to be asserted. As the Polar Regions throw up opportunities of commercial resource exploitation of resources, countries such as India need an active share to ensure the basic needs to its teeming millions.

The Focus

Significant global consequences

of a science and geopolitics of polar oceans dialogue can seriously affect our resource map in the next 25 years. A consortium of scientists, policy makers and activists need to put together learning, research and field notes to put forward balanced and enabling views on global positions outlining the role of developing nations such as India. The concerns of the global community ranges from adaptation to survival. The vulnerability ranges within and without nations differ, making the task of sharing polar realms even more arduous.

Objective

To discuss the interface between science and geopolitics in the polar realms as in this region it is science and the presence of the scientific bases of different countries which dictates the geopolitics of the region. There are several areas of concern which require a policy regime in order to be regulated in the interest of preserving the ecology of this area and the Seminar was just a step in that direction as it brought together scientists, academicians as also policy-makers of the Ministries. In the exchange of ideas the Seminar would also suggested further areas of research and development.

The SaGAA Proceedings

- The Plenary Session/ Technical Session 1 titled "Changing Global Positions and Legal Framework of the Polar Realms" with Dr. Sanjay Chaturvedi's presentation of his paper titled "Emerging Science-Geopolitics Interface in the Antarctic: The Indian Challenge".
- The inaugural session began with the lighting of the lamp in the Conference Hall by Dr. Shailesh Nayak who was the Hon'ble Chief Guest.
- Welcome Address by Prof. Pandey, Chairman of the Organizing Committee.
- Brief addresses by Dr. Ajit Tyagi, Dr. N. C. Mehrotra and Dr. Anil K. Gupta.
- Shri Rasik Ravindra, the Guest of Honour, narrating the Nation's First South Pole Expedition.
- The 2nd Technical Session titled "Atmosphere and Microbial Research in the Polar Realms" included paper presentations by: Dr. S. Shivaji- Microbes in Arctic and Antarctic, Dr. Loka Bharthi- Changing Climate and Microbial Resources in Polar Realms, Dr. S.L. Jain- Ozone Hole over Poles: Current Status and Prof. A.D. Singh- Marine Biodiversity variation in the low-latitude region: Possible impact of Polar climatic perturbations.
- The 3rd Technical Session titled "Adventure, Tourism and Geopolitics in Polar Realms" included paper presentations by: Ms. Urmi Papat- Polar Expedition- Becoming an Industry? Ms. Reena Kaushal- Kaspersky Lab, Commonwealth Antarctic Expedition and Ramanuj Kaushik- De-icing of Arctic Routes and its Geopolitical Implications on Indian Ocean Sea Lane of Communication.
- The 4th Technical Session titled "Climate Change, Geology and Mapping of Arctic and Antarctic" included paper presentations by: Dr. V.M. Tiwari- Geophysical Studies in Polar regions: Future Perspectives, Dr. T. Meloth- Warming in Coastal Antarctica based on Ice Core Records and its Implications, Mr. Subba Rao and S. K. Mehta- Survey of India and Indian Scientific Expedition to the Antarctic, Prof.





Dhruv Sen Singh- Glacial and Fluvial Environments of the Ny-Alesund Region, Arctic and Dr. IML Das- Quantitative Studies of Sea-Ice Melting Rates in the Antarctica using SSM/I Data.

● The 5th and last Technical Session titled “ Atmospheric, Oceanic and Microbial Research in Arctic and Antarctic” included paper presentations by: Prof. G.N. Nayak-Suspended Particulate Matter in Southern Ocean- AN approach to understand

source and processes, Dr. R. Ramesh- Stable Isotope and Salinity Variations in the Southern Indian Ocean, Dr. R.P. Lal- A review of Meteorological Observational Programme of the Indian Meteorological Dept. in Antarctica, Prof. A.K. Gwal- Space Weather Studies of Ionosphere in Arctic Region, Dr. N. Singh-Centres of action and Indian Monsoon- A perspective of North and South Polar Highs, Dr. V.D. Mishra-Four Yearly Cycle of Surface Energy fluxes of the

Antarctica ice sheet in Dronning Maud Land, East Antarctica, Prof. Mihir K. Dash- Variation of Barrier Layer in Southern Indian Ocean and Dr. B. C. Arya- Surface Ozone Depletion Events observed at the Indian Arctic Station, Himadri during Spring of 2010.

● The valedictory session was chaired by Dr. S.K. Das. The other panelists on the dais were Dr. P. C. Pandey, Shri Rasik Ravindra, Dr. M. Sudhakar and Dr. R. Ramesh.

SaGAA 2011 Conference Proceedings

SaGAA, 2011 began with the Plenary Session with Prof. Sanjay Chaturvedi presenting his paper on the interplay between science and geopolitics in the Antarctic. The Chair was Prof Rahmatullah Khan who is an eminent international jurist on International Law and presently Secretary to the Indian Society for International Law.

Prof. Sanjay Chaturvedi, Centre for Study of Geopolitics, Dept. of Political Science, Punjab University, Chandigarh



Emerging Science-Geopolitics Interface in the Antarctic: The Indian Challenge

India has started research on the Antarctic since the 1980s focusing on the area of geopolitics in the Antarctic Treaty System (ATS). The ATS currently has 48 participant nations with 8 of them having a

consultative status, India being one such ATCP besides China and Pakistan, to mention a few here.

According to Dr Chaturvedi, presently the ATS stood at the crossroads of an asymmetrical power structure in world politics wherein there existed certain silent delegations in the treaty negotiations and a view of the Antarctic as the ‘global knowledge commons’. The possibility of scientific research and dissemination of information in a peaceful manner wherein India could play a pivotal role in bringing together and representing the Asian continent leading the agenda-setting especially in the field of Bioprospecting. Being an ATCP India could democratize the institution of the ATS from within as also mentioned by Prof. Rahmatullah Khan, ISIL.

The scientific and physical presence in the Antarctic would influence its geopolitics. In this context it is also to be noted that unlike the 12 initial signatories to the AT all the other new members would have to demonstrate ‘substantial scientific activity’ by those desiring Consultative

Status with Veto Power.

From 1904 -1939 mapping the colonial and imperial geography of the Antarctica one came across 7 territorial claims in the region and they were of the following countries - U.K., Argentina, Chile, Australia, France, Norway and New Zealand.

It was in 1956 that India in the U.N. General Assembly proposed a Trusteeship System for Antarctica fearing the possibility of nuclear testing in the region as also the presence of nuclear warships in the Southern Ocean and the fact that any ecological disbalance in this region would adversely affect the monsoons. Though withdrawn later, it was indubitably a major catalyst for the ATS. The right to inspection by the AT Consultative Parties/ ATCPs was provided for in the AT subsequently.

1957-58 onwards science started getting politicized in the region with the Soviets and the Australians setting up bases there in Antarctica. The two semi-claimants in the area have been the U.S. and the S.U. One could say that from the late 1950s science thus became the ‘currency of geopolitics’ used to

establish 'effective occupation' in the area. The 1970s marked the decisive shift towards commercialization of the resources of the region. With oil being found in the Ross Sea and the global oil crisis in the backdrop, commercial equations came to the fore. The extended continental shelf of the sub-continent islands also had hydrocarbon reserves which again was a source of oil, the exact figure having been published by the Australian scholars. Other contentious issues like fishing by the Australians and whaling by the Japanese also required deliberation and peaceful resolution. Addressing the burning issue of the growing trade of bioprospecting Dr Chaturvedi mentioned the minerals negotiations and the role of the

big biotechnological companies in the areas of pharmaceuticals, enzymes, surgery, cosmetics, chemistry and the food and agricultural industries. The two conventions that would apply to the issue of bioprospecting and to which it should be subjected were the Convention on Biological Diversity (CBD) and the Convention on the Law of the Seas. (UNCLOS) The subject of bioprospecting blurred the fine line of division between scientific research and its commercialization in order to develop marketable biotechnological inventions under the protection of the Patents Act (patenting of bioactive substances) thus exploiting the chemical and genetic material of the world's biological resources. This was a crucial area which

was also not covered by the Environmental Impact Assessments (EIA) clause of the Madrid Protocol of 1991. The UNCLOS also only refers to the exploitation of minerals and not to bioprospecting of biological and genetic resources. Thus Dr. Chaturvedi suggested that maybe the ATCPs would have to modify some of the provisions of the Madrid Protocol and its annexes in order to address such issues; the need for a comprehensive Antarctic Bioprospecting Policy Regime. What was required was to further study how the scientific discourses and practices flowing from them including the implications of climate change contributed to the consolidation and exercise of geopolitical power in the Antarctic.

Inaugural Session

The ceremonial lamp at the conference hall was lit by the Hon'ble Secretary, Ministry of Earth Sciences (MoES), Dr. Shailesh Nayak, who was the Chief Guest. Introducing the key personalities the Convener of the Seminar and President, LIGHTS, Ms. Sulagna Chattopadhyay, invited Dr. P. C. Pandey, Professor, IIT and Chairman of the Organizing Committee to open the Seminar with his speech.

Dr. P.C. Pandey,
Chairman of the Organizing
Committee of SaGAA, 2011
Professor, IIT, Kharagpur



Welcome address by Dr.P.C PANDEY

Dr.P.C. Pandey is a renowned scientist in the fields of Satellite Oceanography, Remote Sensing, Atmospheric Science, Antarctic and Climate Change.

Dr. Pandey in warm-heartedly welcoming all the eminent scientists present, specially expressed his gratitude towards Dr. Shailesh Nayak, Secretary, MoES, whose presence itself marked the importance of the Seminar and the event was officially declared open.

He laid emphasis on the fact that in this post-colonial, multipolar and peaceful era of independence, the twin concerns of governance was 'Science' and the 'Protection of the Antarctic Environment'. Science and related research was the order of the day. To prove

his point he mentioned the 4th Report of the Intergovernmental Panel on Climate Change (IPCC) wherein a full chapter had been devoted to Arctic and the Antarctic Environment due to the growing concern on climate change.

Thus in his opinion though science took the centre stage the significance/role played by the available resources in these regions in the areas of genetics, meteorology, mineralogy, to mention a few could not be undermined. Talking of the relevant overlapping legal regimes he mentioned the Antarctic Treaty, Article 7 of the Protocol on Environmental Protection and the Law of the Seas. India was a signatory to the Antarctic Treaty since 1983.

The strategic significance of the Indian Ocean as an important trade route as well





as India's growing commitment to Arctic and Antarctic science was also confirmed by Dr. Pandey. He thanked many of the key actors who have aided and undertaken as well scientific research in these areas like MoES who supported the collection of baseline data for EIA studies and the establishment of BHARTI- the Third Indian Antarctic Station, Dr. Rasik Ravindra, Director, National Centre for Antarctic and Ocean Research (NCAOR), Goa and the efforts of the Antarctic Study Centre which had acted as a forerunner in planning, promoting, co-ordinating and executing the entire gamut of polar science and logistical activities so as to ensure a perceptible and influential presence of India in Antarctic Studies.

Dr. Ajit Tyagi, DG, IMD, Guest of Honour, SaGAA, 2011



The discussion was carried forth by Dr. Ajit Tyagi, Director General, India Meteorological Department, New Delhi. He was the Guest of Honour at SaGAA, 2011.

He spoke of his visit to Maitri, one of the polar stations of India, duly acknowledging the support received from the MoES and the Indian Air force. Like Prof. Pandey he too agreed that basic knowledge derived from the region would be used to benefit society at large and suggested that in future there could be a better co-ordination among institutions regarding sharing of the data collected thus enriching the content of

such studies making it truly multi-disciplinary. The areas of study he laid stress on were the linkages between the Southern Ocean and the Antarctic as regards the issue of the monsoons and the impact of the changing Arctic weather on the Southern Hemisphere. In the nutshell, the issue of Climate Change and the Southern Ocean.

Praising the expedition to the South Pole he felt that it had received good logistical support and had involved substantial and detailed planning for which he duly thanked the Ministry and all the others involved. Talking of atmospheric changes he also pointed out that the effect of growing tourism in this area needed to be studied.

Dr. N.C. Mehrotra, Director, Birbal Sahni Institute of Palaeobotany, Lucknow



Dr. N. C. Mehrotra in his brief address simply pointed out the key contributions of the Institute in the areas of Paleoclimatic studies, Paleobotany, Geochemistry, the changing sea-levels and the three Arctic expeditions from 2008-'10.

Dr. Anil K. Gupta, Director, of Wadia Institute of Himalayan Geology



Equally short though invaluable was Dr. Anil K.

Gupta's address. He is the Director of Wadia Institute of Himalayan Geology. To him both science and geopolitics was equally important. Changes in the Arctics influenced the monsoons and the Himalayan glaciers. And hence, this region was important not only for its mineral and other natural resources but also for future climatic changes. He called Himalayas the third pole and added that atmospheric studies should include Himalayas within its purview.

Dr. Rasik Ravindra, Director NCAOR, Guest of Honour, SaGAA 2011



Narration of the Nation's First South Pole Expedition

The Director of NCAOR, Dr. Rasik Ravindra took the opportunity to share his experiences of the nation's first South Pole Expedition. The team comprised of seven members which was lead by Dr. Ravindra himself, who recalled that it began with handing off the tricolor flag of India by Shri Prithviraj Chauhan, Chief Minister (Maharashtra) and the former Minister of Earth Sciences to the Secretary (MoES) Dr. Shailesh Nayak to launch the expedition. Dr. Ravindra further stressed that the expedition was simultaneously launched by his Excellency the Governor of Goa, Dr. S. S. Sidhu, the seat of NCAOR from where the expedition was to begin.

The Director praising his team members cited a quote from the book 'The Last Great Quest: Captain Scott's Antarctic

Sacrifice' which has been his source of inspiration: *"If you have the intellectual passion and the physical strength to give it a shape, go ahead. In whatever you do it will be a step towards the knowledge of mankind."*

The team had reached Cape Town, South Africa in the early hours of 3rd November, 2010 by air from Mumbai (via Dubai) and they left for Antarctica on 6th November by ALCI flight and landed at Novolazarevskaya (NOVO) Run Way on the 7th which is 7 kilometers away from Indian station, Maitri.

This expedition had great historical value as the ceremonial pole had the national flags of the all the original signatories of Antarctic Treaty except the Indian tricolor. It also commemorated the International Geophysical Year. He too like Dr. Pandey highlighted the tremendous possibilities of scientific research in the polar realms.

Dr. Ravindra went ahead to give a detailed account of the expedition. The South Pole expedition team started their traverse to Pole on 13th November 9am after a small function held at Maitri. Unlike the Norwegians and U.S scientists the Indian scientists followed a shorter route avoiding the crevasse that marks the southern extreme of the Earth.

Subsequently, the four Arctic trucks (Hilux) carrying the entire expedition team along with the luggage and equipments started their travel to the South Pole. The team included 6 scientists and 2 vehicle mechanics from Indian side and 4 supportive staff from ALCI (two ice truck drivers and two Icelanders).

The team was Equipped

with a dual frequency ground penetrating radar, shallow ice coring machine, digital flux-gate magnetometer, vehicle mounted weather station and a video camera. The team also carried polar clothing, generators, cooking utensils, ropes, batteries - everything needed for the 40 plus day journey to South Pole.

En-route the team got engaged in several scientific activities like collection of meteorological and glaciological data. The team collected atmospheric aerosol data and drilled short ice cores from pole and surrounding areas even in extreme climatic condition. The team also conducted GPR survey to study bed rock topography and sub-surface ice structure near the pole. The en-route fuel dump for the South Pole team was made at 83°S by a feeder flight of ALCI, which flew from NOVO runway on 17th November. The flight also brought a radiator for Arctic Trucks, gas regulators and food items for the South Pole team. They also captured different glacial & geomorphologic landforms like sastrugis, u shaped valleys, flora & fauna throughout their travel.

On 21st November the Indian South Pole expedition team reached a position of 90°S and 0°W, where 360 degree lines of longitude collide and which is the southernmost point on the surface of the Earth. In their entire journey the team had covered a total distance of almost 2240kms and was camped at a place where the ice thickness was almost 3000 m. The expedition team then hoisted Indian flag at South Pole.

There were no native resident plants or animals

at the South Pole due to its exceptionally harsh climate. However occasionally birds like the skuas were noticed by the scientists reaching the pole from their native habitat near the coast.

On 24th November, 2010 the expedition team started their return journey from the South Pole. To the satisfaction of the team members and as a significant step ahead in nation's scientific research interests, huge volumes of raw data had been collected for further studies.

Dr. Shailesh Nayak



Inaugural address

Dr. Shailesh Nayak spoke of the factors affecting the glaciers which were affected not only by changes in temperatures but also by human intervention. What had to be further researched upon was how the mass and volume of the glaciers were changing. Variations of space and time also required further studies. Regular weather forecasts from the stations in Antarctica did help a lot even in the planning of the South Pole expedition. As far as geopolitics was concerned, issues such as deep seabed drilling, tourism, fishing, etc needed to be addressed and what was required was definitive policy of the GOI on these issues.





TECHNICAL SESSION 1: Changing Global Positions and Legal Framework of the Polar Realms

Chair: **Dr. R. Ravindran,**
Director, NCAOR

Dr. S. Rajan,
National Centre for
Antarctic and Ocean
Research, Goa



Antarctic Continental Shelf and the Law of the Sea: A Future Winter of Discontentment?

Several countries like Australia, Norway and Argentina have already laid claims to the continental shelf of Antarctica and others like UK, France and New Zealand hope to do so in the near future. It is these claims that have been disused in the paper, its scientific and legal implications. It goes into a detailed discussion on the UN Convention on the Law of the Sea (UNCLOS), 1982. The role of the UN Commission on the limits of the Continental Shelf which is the regulatory body beyond the 200 nautical line limit is discussed in the paper. It is this body that reviews all such claims on the continental shelf. The article also discusses in detail the 1959 Antarctic Treaty System. Article 77 of the UNCLOS is particularly contentious as it gives the coastal states the right to explore and exploit the natural resources of the continental shelf. The article also importantly states India's stand regarding this issue. India like Russia and Japan do not recognize any claim to

territories in Antarctica and no such right emanating from it on the continental shelf adjacent to Antarctica.

Prof. S.S. Deora,
HOD, Political Geography
Division, SIS, JNU,
New Delhi



Geopolitics of Natural Resource Utilization in Greenland and Faeroes Islands.

He started his presentation by drawing attention of the people to the specific geographical positioning and characteristics of this area. Briefly mentioning the UN Convention on the Law of the Sea and the 7 claimants of the Antarctic pie he went on to highlight the differences in these two regions. Greenland was far richer in mineral resources like lead, iron, zinc, gold, uranium and even petroleum besides the presence of livestock, sea mammals and agricultural products there unlike the Faeroes Islands. The sea here also contained Vitamin A. It was also suitable for tourist activities. The Faeroes Islands had only some prospect of oil explorations but nothing more. He also said that there were not many outsiders in these regions and the main contenders in this region were Sweden, Norway and Denmark. Talking of the existing transport and communications in Greenland he also mentioned the speech of the President of Iceland last year wherein he had talked of Glaciology.

Dr. Luther M. Rangreji,
Senior Legal Officer, Legal
And Treaties Division, MEA



Protection of the Arctic Region: Are there some lessons to learn from the Antarctic Treaty System and International Law?

His paper was on the geopolitics of the Arctic region with reference to the existing legal regime due to the changing climate of the region and the opening up of new shipping routes. Keeping in mind the finding of petroleum and natural gas reserves in the region alongside the fishing and other prospects, he talked of the legal regime like the UN Convention on the Law of the Sea, The role of the International Maritime Organization Conventions, the Prevention of Pollution Conventions along with the Liability and Compensation Conventions in case of such pollution and the Fisheries Agreements. He also spoke at length of the Arctic Council and its institutional mechanism.

Dr. Rasik Ravindra, Director,
National Centre for Antarctic
and Ocean Research, Goa



India in Arctic and Antarctica and its Geopolitical Significance.

In the backdrop of the increased exploration and exploitation

of the polar regions as this area is rich in fresh water resources, untapped mineral and hydrocarbons he talks of the Indian Polar Programme- the Antarctic Programme- the expeditions, research bases and the data collected by them, the Antarctic Treaty, Scientific Committee on Antarctic Research (SCAR wherein India is an Observer) and Council of Managers of the National Antarctic Programme

(COMNAP), research at the Indian Arctic Station- Himadri which is the Arctic Programme and thirdly, the Southern Ocean expeditions. He himself is the Vice-President of the SCAR Delegate Meet and is on the Executive Committee of the COMNAP. India also plays an active role in the Asian Forum in Polar Sciences alongside China and Japan being one of the founding members of the organization. India is

not a member of the Arctic Council as of now but under the Svalbard Treaty it does have the right to conduct exploration in the Svalbard region of the Arctic. With the depletion of the ice cover and the possibilities of opening up of new sea routes, the country needs to develop a long-term strategy in many areas including energy management and environmentally sound tourism.

**Technical Session 2:
Atmosphere and Microbial
Research in the Polar Realms**
Chair: Dr. L.S. Rathore, Head,
Agromet Division, India
Meteorological Dept.
Co-Chair: Dr. R. Ramesh,
Geo-Sciences Director, PRL,
Ahmedabad
Rapporteur: Dr. T. Meloth

Dr. S. Shivaji,
CCMB, Hyderabad



Biodiversity and Biotechnological Applications of Psychrophiles

Biodiversity refers to all life forms including plants, animals, viruses, bacteria, algae, fungi, protozoa etc. Dr. Shivaji focused his present study on the bacterial diversity of Antarctica and especially the taxonomy of the bacteria present.

Till date, 240 novel species of Gram+ and Gram – bacteria had been identified from various habitats of Antarctica ranging from soil, sandstone, fresh water and marine lakes, sea ice, ocean etc. The isolation

of bacteria from various habitats in Antarctica had enabled the scientists to identify them to the species level.

The results led to the identification of 15 new species of Gram+ bacteria and 12 new species of Gram- bacteria. All the new bacterial species were psychrophilic and could be differentiated from the nearest phylogenetic neighbour based on their phenotypic and chemotaxonomic characteristics and also at the 16S rRNA gene sequence level.

Dr. Shivaji stated that in India research in Antarctic Biotechnology had essentially centered around on the following areas:

- i. Biodiversity of Antarctic Microbes
- ii. Biotechnological potential of Antarctic Microbes
- iii. Molecular Basis of the Survival of Antarctic Microbes

Dr. Loka Bharati,
NIO, Goa



Changing Climate and Microbial Research in Polar Realms

Dr. Bharati highlighted the fact that to all those belonging to the field other than microbiology, microbes are synonymous with the outbreaks of endemic or pandemic diseases but contrary to the popular thinking, the microbes are in fact the main drivers of all activities on the planet earth particularly at all types of extreme environments be it the deep sea, thermophilic conditions of hydrothermal vents, hyper saline waters and sediments of salt lakes and psychrotrophic conditions at the poles.

The current climate changes that all were experiencing was attributable to both natural and man- made causes and though the effects of these changes were obvious at the higher trophic levels, it was subtle and far- reaching at the microbial level.

Dr. Bharati highlights the fact that since these micro organisms are the main affecters, respondents and catalysts of these changes, they serve as a source of varied compounds with wide range applications in various fields. These organisms are able to survive in the Arctic,





Antarctic or any extreme environment because of their unique configuration of genes and proteins and hence their importance which is now being increasingly realized.

As she pointed out that the more serious challenge of the present century lies in understanding how best human race can develop new products, technologies and even explores extra terrestrial life at Mars. Thus the need of the hour to increase the pace of basic research in understanding the biodiversity, dynamics and kinetics in these systems during these rapid climate changes.

Dr. S. L. Jain, NPL



Ozone Hole over Poles: Current Status

At the outset Dr. Jain pointed out that with the help of the satellite data from NASA studies had been conducted in this area. A highly sophisticated and hand-held microprocessor based sun-photometer, i.e. MICROTOP-II had been used to measure total ozone, water

vapour, optical depth, etc. at Maitri- the Indian Antarctic Research station for the years 1997, 2002, 2003 and 2004.

The observation revealed that the ozone hole in the year 2002 was not as deep as in the year 2003. The ozone hole area was found to be the minimum in the year 1979 measuring 1.1 million square km and the maximum was found to be 29.9 million square km in the year 2000, after which it had started to decrease. During the year 2010, the maximum ozone hole area was found to be 22.2 million square km.

It was found that the total ozone values in the Arctic were considerably higher than in the Antarctic due to its geographical location being warmer than Antarctica. He highlighted to the fact that the ozone hole data does give indication of the long-term trend and that the measurements show that the CFC concentrations in the stratosphere are leveling off and in the lowest layer of the atmosphere i.e. the troposphere, the CFC concentrations are on the decline due to the decisions taken by the international community under the Montreal Protocol and its subsequent adjustments and amendments to stop the use of ozone depleting chemicals.

Prof. A. D Singh, Centre for Advanced Study in Geology, Department of Geology, BHU



Marine Biodiversity Variation in the low latitude Region Possible Impact of Polar Climatic Perturbations

The impact of climate change on marine biodiversity and its conservation and management has been the key concern of many modern scientists. In this regard, the professor highlighted that in order to understand the response of marine biota to changes in ocean environment as linked to global climatic fluctuations, studies of how various biotic groups had evolved in the ocean, their diversifications and selective extinctions during certain geological periods became essential.

Dr. Singh pointed out that foraminifera was the object of study as it was very sensitive to changes in ocean environment and that it revealed that within the glacial stage, there have been periods of intensified cold events as recorded from the Greenland ice core.

Session 3: Adventure, Tourism and Geopolitics in Polar Realms **Chair: Prof. S. Chaturvedi**

Ms. Urmi Popat, Proprietor, Manas Publication, Mumbai



Polar Expedition Becoming an Industry?

The challenge of what appears to be an uncontrolled growth of tourism in both the Arctic and the Antarctic was the key note that Ms. Popat highlighted.

She stressed on the fact that in addition to the discussions of tourism and its potential impact on the environment of Antarctica, scientific studies

of the region was a must as envisaged by the Antarctic Treaty signed in December,

1959 and ratified in June, 1961. Tourism would be affected with the onset of global warming, the rising sea levels affecting many native biota there. The need for studies in this area as also proper management regarding these issues required immediate addressal.

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Ms. Reena Kaushal,
Kapersky Lab, Commonwealth
Antarctic Expedition



The largest International Team of Women ever to Ski to the South Pole

To mark the 60th anniversary of the Commonwealth on 29th December 2009, a team of

women from across countries arrived at the Geographic South Pole after skiing 900km from the coast of Antarctica in just about 38 days. As the largest and most international women's team ever to have reached the South Pole, the expedition represented 5 continents, 6 faiths and 7 languages, powerfully demonstrating the potential for fruitful multi-national and multi-faith cooperation.

Every detailed care was taken to minimize the impact of the skiers on the pristine environment there. These included re-packaging of all their expedition food in Punta Arenas to cut out a lot of packaging material waste. All waste including human waste was removed by the use of 'Disposable John' bags.

It was a well-planned expedition and keeping in mind the fact that flight to Antarctica increases the carbon footprints, every compensative initiative is now being taken so as to deliver talks on Antarctica and global warming and how an individual can make a difference.

Mr. Ramanuj Kaushik,
Research Scholar, CIPOD,
School of International
Studies, JNU



De- Icing of Arctic Routes and its Commonwealth Implications on Indian Ocean Sea Lane of Communication

The research scholar from JNU highlighted that the Indian Ocean region suffers from a high level of international and internal conflict and a key venue for international piracy. It is also the locus of 70% of the world's disasters. In this perspective India's central location in the Indian Ocean is vital not only for India's lifelines but also for much of the wherewithal needed for India's rapid economic development and subsequent prosperity. To this direction the de-icing of the Arctic Sea has added to the discourse and the prospect of trade which will affect much of the trade relationships between South Asia and East Asia.



**Technical Session 4:
Climate Change, Geology
and Mapping of Arctic and
Antarctic**

Chair: Dr. M. Sudhakar,
Advisor, MoES

Co-Chair: Prof. A. K. Gwal,
HOD, Dept. of Physics,
Barkatullah University,
Bhopal

Rapporteur: Dr Javed Beg,
NCAOR

Dr. V. M. Tiwari,
Gravity and Magnetic Studies
Group, NGRI, Hyderabad



Geophysical Studies in Polar Regions: Future Perspective

The speaker noted that the global efforts of geophysical observations such as seismic tomographic models, satellite based estimates of present-

day ice mass balance and isostatic rebound estimates from GPS contributed to the unravelling of the link between cryospheric and tectonic processes.

It also paved the way for better planning of geophysical experiments in the polar regions. In spite of the dense deployments of seismological stations globally, the polar regions still remain sparsely instrumented and hence a number of key issues related to the crust-mantle structure of the cratonic nuclei,



their relation to the anomalous surface topography (like in Antarctica), thickness of the ice sheets and nature of their deformation, needed to be understood.

Seismological data from the Polar Regions is also important in unravelling some of the fundamental issues like anisotropy of the inner core, in view of the parallelarity of the axis of symmetry with the earth's spin axis. Glacial quakes, which were unnoticed earlier, have now been reported from teleseismic records but small glacial quakes are still undetected and require better local seismological coverage.

In this perspective, Dr. Tiwari discussed diverse possibilities of geophysical experiments particularly based on measuring and modelling of seismological, gravimetric and GPS data for geodynamic studies vis- a-vis lithospheric deformation in the polar regions due to large glacier melts. Concurrently GPS data could also be used for atmospheric modeling (TEC and water vapour).

S.K. Mehta, Officer Surveyor, Sol, Dehradun



Survey of India and Indian Scientific Expeditions to the Antarctic

Established in 1767, Survey of India (SOI) is the oldest scientific department of India. Continuing its tradition, the Survey of India has been actively participating in the scientific and geopolitical

activities in the Antarctic since 1991 when its first scientific team explored the possibilities of Topographical Mapping and Geo-physical studies in Antarctic. During 10th Expedition in 1991-92, Primary control for surveying activities was established in the Antarctic for the first time.

In the successive expeditions, mapping on scale 1:5,000 with contour interval 5m and on scale 1:1,000 with 1 metre contour interval have been taken up around Schirmacher Oasis near Maitri. Survey of India, has established 27 GPS stations for densification of control work for mapping and neo-tectonic movement studies of the region. Seven days GPS campaign has also been carried out to monitor the plate movement studies of Antarctic plate with respect to Indian plate. Dr Rao affirmed that the SOI would continue to collaborate with other participating organizations and countries.

Dr. Thamban Meloth, Project Director, NCAOR, Goa



Warming in coastal Antarctica based on ice core records and its Implications

The Project Director from NCAOR firmly articulated the fact that the Antarctic climate system fluctuates on a sub-annual to millennial time scale, with a complex interplay of the ice-sheet, ocean, sea-ice, and atmosphere.

Scrutiny of instrumental data from Antarctica based on

the few available records reveal that Antarctica had undergone significant changes in recent decades with an increase in atmospheric temperature in most parts of the Antarctic continent.

Considering the importance of understanding the Antarctic environmental change in the context of global warming, Indian researchers have made systematic efforts to retrieve and study ice-core records from the coastal regions of East Antarctica. The re-constructed temperature records of the ice cores reported here as well as the available observational data suggest that the coastal regions of Dronning Maud Land in East Antarctica are experiencing significant warming in the recent decades.

The findings of the Indian polar scientists will have significant implications for the coastal Antarctic ice-sheet stability necessitating a detailed study of the spatial and temporal variability of Antarctic warming based on a combination of instrumental and proxy records.

I. M. L. Das, Department of Physics, University of Allahabad, Allahabad



Quantitative Studies of Sea-Ice Melting Rates in the Antarctic using SSM/I Data

Solar heating of the surface during summer resulted in the increase of snow / ice wetness and development of melt ponds, which in turn, significantly reduced the regionally averaged summer

time albedo³. This reduction in albedo plays an important role in the Polar Regions.

The monthly sea-ice extents were assumed to correspond to the 15th day of each month. The mid-day of the month of August i.e. 15th August was allocated the time $t = 0$ which has been taken to correspond to the maximum sea-ice area during the study period. Then $t = 184$ corresponds to the mid-day of the month of February i.e. 15th February which has been taken to correspond to the minimum sea-ice area during the period of study. The SSM/I ice concentration data from 1988-2006 was used to assess the impact of the feedback processes.

The melting rate obtained from the SSM/I data was compared with the theoretical melting rate obtained by differentiating a theoretical curve based on the effect of seasonal cycle of solar irradiance. The feedback acts with a response delay of 61 days and increases the sea-ice melting rate by 1.57 ± 0.13 times. The amount of sea-ice present in the Polar Regions determines the future of Antarctic sea ice variability. Hence the need to take the feedback processes into consideration while modeling the sea-ice system in

the Polar Regions.

Dhruv Sen Singh,
Centre of Advanced Study
in Geology, University of
Lucknow, Lucknow



Glacial and Fluvial Environments of the Ny-Alesund Region, Arctic

Ny-Alesund region exhibits complex topography and geomorphic features evolved by various sedimentary environments under direct control of climate and tectonics. The geomorphic features such as moraines, alluvial fans, channel bars, lacustrine deposits, deltaic deposits, marine terraces are evolved by glaciers during glaciation and by mass movement, fluvial, lake, delta, and sea respectively during de-glaciations.

The analysis of glacial and fluvial landforms was conducted on the basis of documentation of small valley glaciers and the streams originating from it. The analysis and documentation of geomorphic features and their associated depositional environment are important in

understanding the landforms and landscape evolution and their relationship with the climate. Therefore, by studying the landforms and its sediment, it would be possible to reconstruct the surface processes/depositional sedimentary environment and hence the prevailing climate.

A model for landscape evolution and geomorphic feature was proposed which could be used as an analogue to interpret the rock record. The understanding of geomorphic features and their associated surface process/sedimentary environment would be the first step in describing the landscape evolution.

The main sedimentary environment active for the formation of landforms and sediments were glacial during glacial stage, while during de-glaciation many sedimentary environments came into existence and contributed in the shaping of the landscape of the area. The present study describes that the landscape of the Ny-Alesund, Svalbard, Arctic is carved by the last period of glacial activity followed by surface processes/sedimentary environments which evolved during the inter-glacial period influenced by climate and tectonics.



Technical Session 5:
Atmosphere, Oceanic and
Microbial Research in Arctic
and Antarctic

Chair: Dr. P C Pandey, Prof
CORAL, IIT Kharagpur

Co-Chair: Dr S Sivaji, CCMB,
Hyderabad

Rapporteur: Dr V M
Tiwari, Gravity and Magnetic
Studies Group, NGRI,
Hyderabad

R. Ramesh,
Physical Research Laboratory,
Navrangpura, Ahmedabad



Stable isotope and salinity
variations in the Southern

Indian Ocean

Melting causes salt-free isotopically depleted (i.e., depleted in ^{18}O and D) water to mix with salty, isotopically enriched sea water, thus defining a linear relation between the two. During the second expedition to the Southern Ocean, water samples were collected and salinity and stable isotopic compositions



were measured.

The results, when compared with measurements that were made decades ago independently by other groups, show that there is no significant change in the salinity-stable isotope relation. This implies that the melting of the Antarctic ice sheet has not yet started influencing the Indian sector of the Southern Ocean. A theoretical model connecting stable isotope ratios and salinity has been developed and results will be examined in this light.

Dr. Mihir Kumar Dash,
CORAL, Indian Institute of
Technology, Kharagpur



Variation of Barrier Layer in the Southern Indian Ocean

The Antarctic Circumpolar Current connecting the three ocean basins – the Atlantic, the Indian and the Pacific forms a crucial part of the global oceanic circulation system that transports water, heat, salt, gases and nutrients around the world. The bottom water formed here renews and ventilates the lowest layers of the global ocean well into the North Atlantic.

With this in mind, Dr. Dash attempted to describe the variation in the barrier layer in the South-Central India Ocean (latitude: 50°S-60°S; longitude: 60°E-90°E) using the salinity and temperature profiles collected over nearly 30 years (from NODC) and the ARGO floats over nearly 10 years. Averaged barrier layers for each 2° × 2° region were calculated using the individual

temperature and salinity profiles for the months of January and February from 1978 to 2007.

Prof. G. N. Nayak,
Department of Marine
Sciences, Goa University, Goa



Suspended particulate Matter in the Southern Ocean- An Approach to Understand the Source and Processes

Geologically the Southern Ocean is the youngest of the world's oceans formed around 30 million years ago when Antarctica and South America moved apart. It is considered as a crucial area in the contemporary cycle of matter. Two major sources responsible for supply of particles to the ocean are biogenic particles formed as a result of planktonic metabolism and lithogenic particles, mostly clay and rock detritus, transported from continents by rivers, coastal erosion and wind. Also, as a result of re-suspension of sediments, a large volume of lithogenic particles is transferred within the interior of the ocean.

The mass concentrations of suspended particulate matter (SPM) in the ocean vary in different regions and at different depths due to various biotic and abiotic factors further depending on the geographical location, its productivity and the dynamics of its water masses. The knowledge on the distribution of SPM is thus an important prerequisite for the description and prediction of the ecological conditions.

Research in the Southern Ocean underlines the sensitivity of the region to climate

variability and its importance in understanding climate change. Continuous and long term monitoring is essential in understanding the climatic changes in the Southern Ocean. An area to be explored in the future Southern Ocean expeditions. The professor moreover proposed the study of the component composition of SPM in order to understand the source of matter and productivity.

Dr. B.C. Arya,
Radio and Atmospheric
Division, National Physical
Laboratory, CSIR, New Delhi



Surface Ozone Depletion Events observed at Indian Arctic Station Himadri, during Spring of 2010

Episodes of low surface ozone concentrations at Barrow, Alaska (71°N, 157°W, 1981, 1986), at Alert, northern Canada (82.5°N, 62.3°W, 1986). Ny-Alesund (79°N, 12°E) was observed. Low surface ozone concentrations were also observed in Antarctic (Halley and Neumayer stations). Here, ozone levels dropped from typical levels of 30 ppb to below 10 ppb, or even below detection limit. These events as Dr. Arya pointed out were called "Ozone Depletion Events (ODEs)".

Most observations of ODEs have been recorded from coastal sites when the ocean is frozen and snow covered. Vertically, most ODEs extended from the surface to 100-400 meter in early spring and 1 to 2 Km in late spring. Ozone depletion events are most commonly

observed during springtime, March to May in the Arctic and August to October in the Antarctic.

The main source of reactive bromine species (Br and BrO) from sea salt that is released via a series of photo-chemical and heterogeneous reactions known as the bromine explosion was found to be involved in the ozone depletion process. Trajectory analysis shows that the observed low ozone events were closely linked to the transport direction.

Dr. Nityanand Singh,
Indian Institute of Tropical
Meteorology, Pune



Changing Relationship between Centers of Action and Indian Monsoon

Adequate fresh water availability is essential for the spiritual growth of human beings and a healthy physical-material human society. Drastic and complicated spatial and temporal changes are expected in the general atmosphere, the oriental monsoon circulation and in the availability of fresh water across the globe. This is due to the global warming with the southern hemisphere warming at a faster rate than northern hemisphere.

The sole objective of the present study was to understand association between Oriental-Indian monsoon circulation and the different eight highs during the warmer global troposphere. His studies revealed that higher the temperature of the global troposphere, greater

the participation-role of the South Polar High in the general atmospheric and Oriental Monsoon circulations. Warmer boreal winter followed by warmer austral winter was a reliable indicator of occurrence-intensification of El Niño (CC=-0.38).

He further stated that probably there would be lesser exchange of mass and moisture between the hemispheres if the winter hemisphere be warmer consecutively and the subsidence in the upper troposphere over North Pacific and South Pacific Highs declined.

Prof. A. K. Gwal,
Space Science Laboratory,
Department of Physics,
Barkatullah University, Bhopal



Space Weather Studies of Ionosphere in the Arctic Region

Such studies enable progress in our ability to identify critical inputs required to specify the geo-space environment at a level in order to minimize impact on technology, human society and life and to support the development of dependable, robust models that can predict conditions in entire Sun-Earth system and all of its interacting components. It is true that the sun is the cause of all effect felt on the atmosphere of the earth.

The study of loss of lock was carried out at low latitude station and at a high latitude station. The data for low latitude was collected at Bhopal station during February, 2008 while for the study taken

on the high latitude, the data was collected at Indian Station at North Pole 'HIMADRI' [Ny-alesund (78.9°N Lat. and 11.9°E Long.), Norway] from June 17, 2008 to July 17, 2008 during the period of low solar activity.

In the study it is found that though the prime cause of formation of ions is the sun's EUV radiation, the day to day variability of TEC have very poor correlation with solar 10.7 cm flux. A good correlation between the observed ionosphere parameters and solar activity variations is found especially from the autumn to the winter seasons. The effect of magnetic storms on the ionosphere has been studied by many and they have suggested that during storms, if due to some reasons the composition of the medium changes, this in turn may give rise to loss of coefficients thus decreasing the electron density Nmax. This may be true for TEC as well. Dr Gwal also noted that during storms the electric field structure in the ionosphere was affected due to some sort of coupling with the polar region or magnetosphere which again complicated the effect at low latitude ionization anomaly.

Dr. V D Mishra,
Deputy Director, SASE,
Chandigarh





Four yearly cycle of surface energy fluxes of the Antarctic ice sheet in Dronning Maud Land, East Antarctica

Dr. V. D. Mishra presented the study estimates of radiative and turbulent energy fluxes of blue ice of the Antarctic ice-sheet from the period of February, 2006 to November, 2010 in Dronning Maudland, East Antarctica. Hourly snow meteorological parameters were recorded by automatic weather station (AWS) on the glacier surface.

Snow-meteorological parameters, air temperature, relative humidity, wind speed, wind direction, incoming solar radiation, outgoing solar radiation, atmospheric pressure and surface temperature are the main parameters used in the energy balance model. Four yearly average air temperature and average wind speed was observed at -12.5°C and 10.3m/s respectively at the observation location. A simple energy balance model was used to evaluate the surface energy fluxes from measured meteorological quantities. Sensible heat flux and net shortwave flux were observed the main heat source for the ice-sheet while latent heat flux

and net long wave flux were observed the main heat sink. Net shortwave flux was observed the dominant heat source during summer while sensible heat flux was observed the dominant heat source during winter. Latent heat flux and net long wave flux were observed the main heat sink during the observation period with four yearly average values of -48Wm^{-2} and -50Wm^{-2} . Sublimation was observed high at the observation location with approximately 4.6cm per month.

Dr. R. P. Lal,
Director, IMD



A Review of Meteorological Observational Programme of India Meteorological Department in Antarctica

Antarctica has attracted the attention of scientific community all over the world since it is one of the most important climate regimes with the potential to influence long-term global climatic

patterns. The Speaker noted the contributions made by the India Meteorological Department to Antarctic meteorology with the establishment of scientific stations Dakshin Gangotri and Maitri.

Continual record of surface meteorological observations at Dakshin Gangotri and Maitri indicates that the weather over Antarctica experiences large seasonal variations. The climatology of the station-Maitri, gives several interesting indications concerning the climate of Schirmacher Oasis.

The study shows a cooling trend of 0.260C per decade. A similar significant negative trend has been observed in other meteorological parameters such as MSL pressure, wind, number of days with precipitation and the number of blizzard days. In view of these facts it is apparent that continuing polar records of unchanging environment of Maitri will be extremely valuable in monitoring the global climatic changes in the future. There is no doubt that the long-term data being archived by IMD has tremendous potential and significance for understanding the meteorology and climate of Antarctica.



Concluding Session of SaGAA, 2011

The valedictory session was chaired by Dr. S.K. Das. The other panelists on the dais were Dr. Pandey, Dr. Ravindran, Dr. M.Sudhakar and Dr. R. Ramesh

Dr. M. Sudhakar, MoES started by pointing out that the Southern Ocean needed to be studied more. The Antarctic

was already being researched upon for the last 30 years and the geology of the region was more-or-less understood. Successful expeditions to the Southern Ocean had been undertaken since 2004 but just talking of those was not enough. Researchers needed to find the problem areas regarding the Southern Ocean and conduct studies on those. A future and key area of study as he put it was the response of the Southern Ocean in terms of Antarctica influencing.

Dr. Ramesh, PRL recognizing the fact that more international publications were now available than yester years on the issues pertaining to these regions, further acknowledged the logistical support provided by **Dr. Rasik Ravindra**, NCAOR. Stressing the need to focus on scientific problems he mentioned the IMD brainstorming session on polar realms in September last year. Discussions such as these would lead to newer areas of research. He emphasized the need for academic training programmes recruiting and educating people of various disciplines on Antarctica. He mentioned the new training programme of the MoES in this regard. Dr. Rasik Ravindra, NCAOR, talking of the paradigm shift of the Govt. Of India (GOI) since 1983 when India acceded to the Antarctica Treaty stressed that one needed to be cautious in taking a very aggressive/ assertive stand as it needed to be supported by facts. Herein referring to Dr. Rahmatullah. Khan's, ISIL presentation. According to him it was the duty of the Parliament to decide legislation and policy-making regarding these issues and liability annex of the GOI was

a rather complex and difficult area. He further added that people like Reena Kaushal who was part of the expedition to the South Pole could spread awareness among the schools regarding these issues. Taking stock of all the sessions he started with the 1st Session (titled Changing Global Positions & Legal Framework of the Polar Realms) regarding the continental shelf and geopolitics. He noted that the gain of 1 million sq. area of coastline has been a feather in the cap of the country. Part submission of a report on the 7000 km long coastline had already taken place. He mentioned the names of institutions which helped in collecting the data like the NIO. He also stated the fact that India had been invited to join the International Arctic Science Committee (IASC) as an Observer. He further expressed hope that the country would soon join the Arctic Council. He mentioned Dr. L. Rangrej's presentation on the politics of Arctics but did not elaborate upon it.

Dr. S.K. Das, MoES in drawing the discussion to a close said that in the exchange of knowledge that had taken place in the workshop, it had provided a platform for new ideas and programmes which the Ministry could take up as the 3rd station's programme. He harped on the need for long-term multi-dimensional programmes involving several institutional actors within its ambit.

Dr. P.C. Pandey, IIT, Kharagpur commented that though it would indeed be a hard task competing with the rest of the world, the sky was the limit. The

3rd station in the Antarctic was only the beginning. He too was of the opinion that the need of the hour was to focus on science and microbiology and not talk of Bioprospecting and highlighting controversial issues. In the words of the country's erstwhile President- Dr. A.P.J. Abdul Kalam he said that science was empowering. He went on to compliment LIGHTS for the hard work they had put into organizing and successfully carrying through the Seminar. As **Dr. G. N. Nayak**, Goa University aptly stated such programmes were but a seed growing into a tree.

Dr. S. Shivaji, CCMB drawing attention to the fact of ongoing programmes in Biology on the Arctic, Antarctic and the Southern Ocean articulated the need for genome sequencing of the bacterium which is present in these areas. These bacteria, he noted, were one of a kind which could produce enzymes being active under 20 C. Genome analysis of such bacteria would span 2-3 years. It was imperative to study their structures and functions as the technology was now available in the country and this in turn would produce or lead to the development of better R & D in the country. If this were done, he contended that the scientists of this country could conduct further experiments with genes and thus embark upon thereto untread and unexplored areas of scientific research.

Dr. T. Meloth, NCAOR just outlined the topics as discussed in Session II as he was the Rapporteur for this session regarding the depleting ozone layer and marine diversity. The Session was titled Atmosphere and Microbial Research in the





Polar Realms.)

Dr. Ravindra continued with the summation appreciating the work of Urmi Popat who has been publishing on the polar realms thereby creating awareness about the issues at her own expense. And though he found Ms. Reena's expedition to the South Pole highly commendable, he expressed the hope that perhaps next time she would approach the MoES or NCAOR for funding of such expeditions. Session III was titled Adventure, Tourism and Geopolitics in Polar Realms.

Talking of Session IV (titled Climate Change, Geology

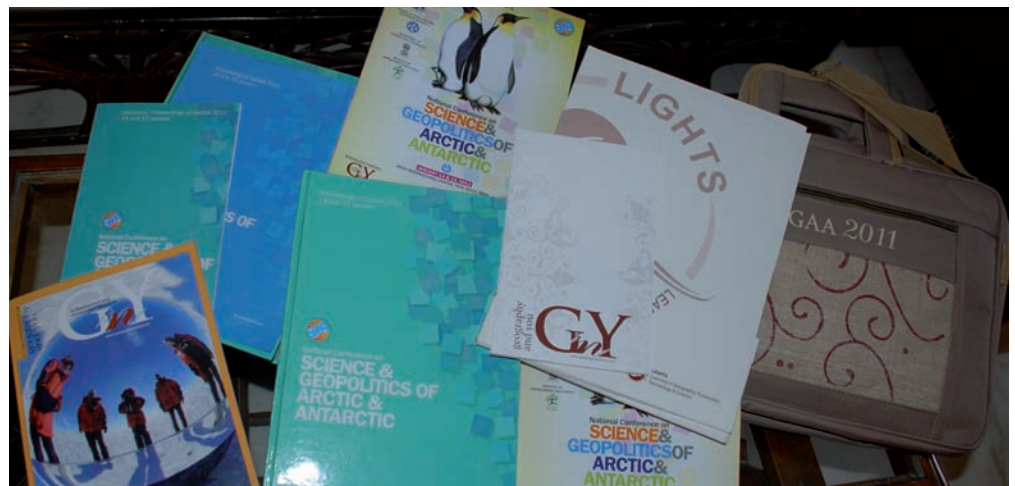
and Mapping of Arctic and Antarctic) and the papers presented by Dr. M. Sudhakar and Dr. A.K.Gwal, Dr. Ravindra said that the mapping of the terrain from 150 longitude to 40 was a major achievement, India being the only country in the Antarctic Treaty Secretariat to have done so on such a massive scale and systematically. The mapping of the shifting patterns of species also was laudable.

Dr. V.M. Tiwari, NGRI spoke on Session V referring to the presentations of Dr. S.Shivaji, CCMB and Dr. P.C. Pandey, IIT, Kharagpur. He termed it the

longest technical session of the Seminar. Also referring to Dr. Nityanand Singh's, IITM work he said that the models and data collected on these regions had been good and so was the exhibition.

Referring to the Survey of India he again reiterated that one should be cautious in speaking of delicate and complex international subjects like Antarctica and that no assertions were to be made.

LIGHTS President, Ms. Sulagna Chattopadhyay duly thanked all those present for their participation and patience in bringing the programme to a successful completion.



DELIVERABLES

A bag with SaGAA 2011 embossed on it containing the following:

- A booklet of abstracts
- A booklet of the Biodata of the participants at SaGAA 2011
- A book containing the

proceedings of SaGAA 2011

- A writing pad from G&Y
- A file folder
- A Reynolds blue pen
- A calendar from G&Y
- Two G&Y magazines (March-April and May-June, 2010) were distributed to all the

participants.

- Participation certificate for paper presentation was given to a research scholar from JNU, Mr. Ramanuj Kaushik.
- Participation certificate were also issued to students who attended the seminar.

LIGHTS

1584 B1, Vasant Kunj, New Delhi-110070 E-mail:

geographyandyou2001@yahoo.co.uk

Tel: 011-26122789, Telefax: 011-26892275

www.geographyandyou.in