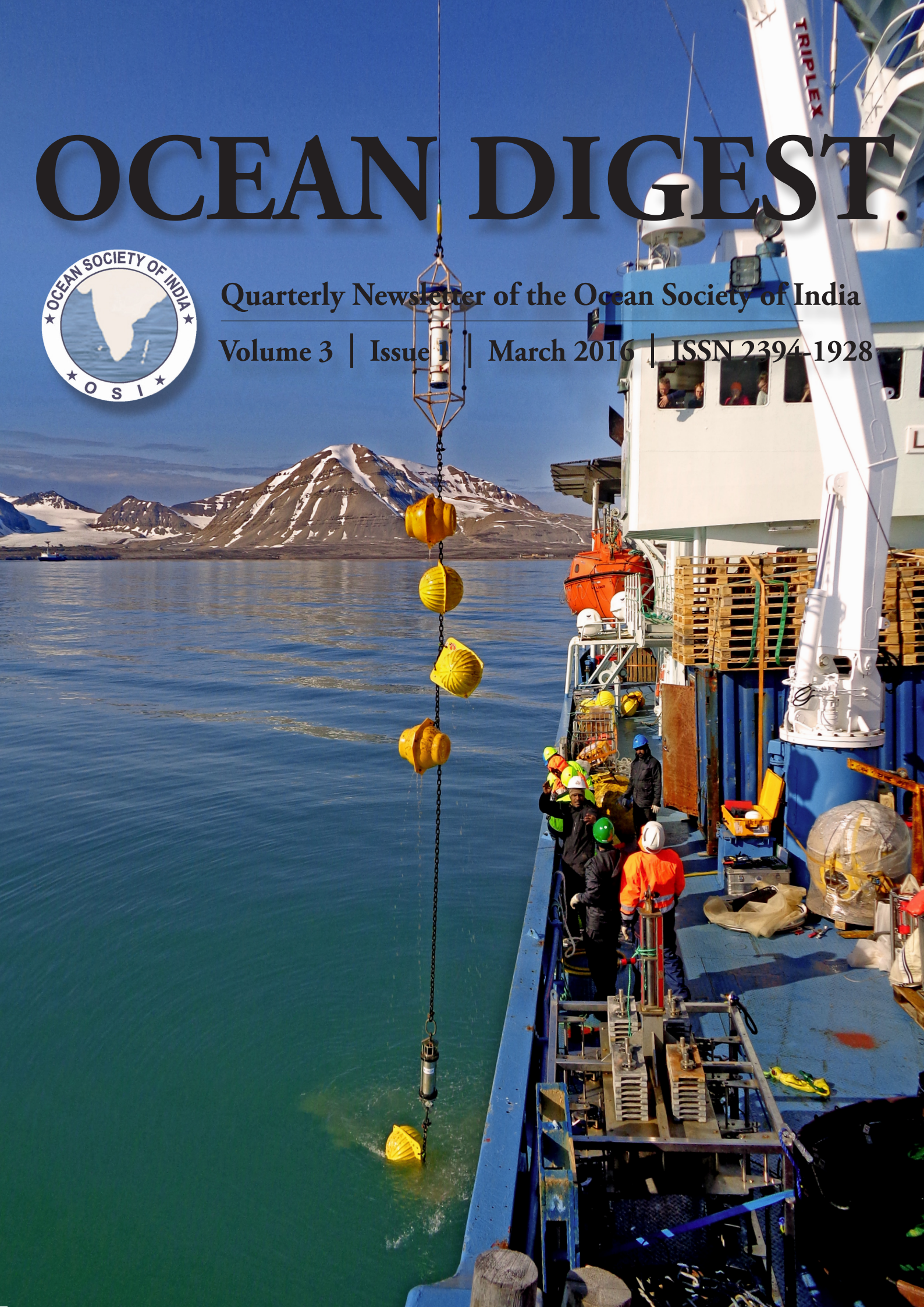
OCEAN DIGEST



Quarterly Newsletter of the Ocean Society of India

Volume 3 | Issue 1 | March 2016 | ISSN 2394-1928

Ocean Observation Techniques

Invited Article

Dr. **R. Venkatesan**

Scientist – G & Head - OOS, National Institute of Ocean Technology, Chennai

1. Introduction

The Ocean Observation Systems (OOS) programme erstwhile National Data buoy programme of NIOT which was initiated in 1996 has grown successfully and has been sustaining in spite of innumerable challenges. The moored buoy systems are collecting and transmitting data in real-time from identified locations in Northern Indian Ocean (NIO). The Moored Buoy Network comprises Deep Sea, Coastal and CAL VAL met ocean Buoy and Tsunami Buoy Network. These moorings remained in the locations and transmitted data showing success of the engineering design during the passage of tropical cyclones such as the HudHud, Phailin, Lehar and Madi cyclones etc., The tsunami buoy systems are unique and India is one of the 12 countries (Australia, China, Ecuador, Japan, Thailand, Malaysia, Russia, Indonesia, USA etc.,) which is part of the Tsunami Early Warning System with its center at INCOIS Hyderabad. The Coastal buoy systems are also deployed and maintained in locations such as Agatti, Andaman, Goa and Chennai and have cost effective INSAT and GPRS telemetry for real time data transmission.

Another feather in the cap to Indian Ocean observational capability is successful installation of Indian moored Observatory in Arctic by NIOT and NCAOR Goa. Thereby having the capability to acquire and transmit data, from Seabed to Desk top (tsunami buoys); Sub surface to atmosphere (marine) and tropical coast to Polar as shown in Figure 1. This has placed India in an enviable position showcasing technological and scientific expertise in the field of Ocean observations to the world for this noticeable and significant contribution.

2. Evolution of Observation methods & tools

As understood from the history, the ocean interior has been mainly observed using instruments lowered from research ships. It is often said that Ocean variables and their variability do not wait for the ship to come for measurements. This problem of under-sampling along with the relatively high cost of these observation platforms has made the scientific community to think of technologies which could provide longer observation times at lower cost through the spatial and temporal density with in the ocean.

Today's technologies evolved different methods to collect data and various tools to explore the ocean by expanding our understanding through systematic and scientific ways. Technologies include platforms such as ship board observation techniques from Research ships and vessels of opportunity like cargo ships, tankers etc., moored buoys, submersibles (or Autonomous) Underwater Vehicles, Autonomous Surface Vehicles, observing systems and sensors, satellite and RF communication etc., Moored buoys are the most common systems for obtaining data and cost effective means which work on an Eulerian approach where a particular region forms the source of interest whereas the Lagrangian approach of data collection uses moving platforms like floats, drifters and Glider etc., through the breadth and depths of

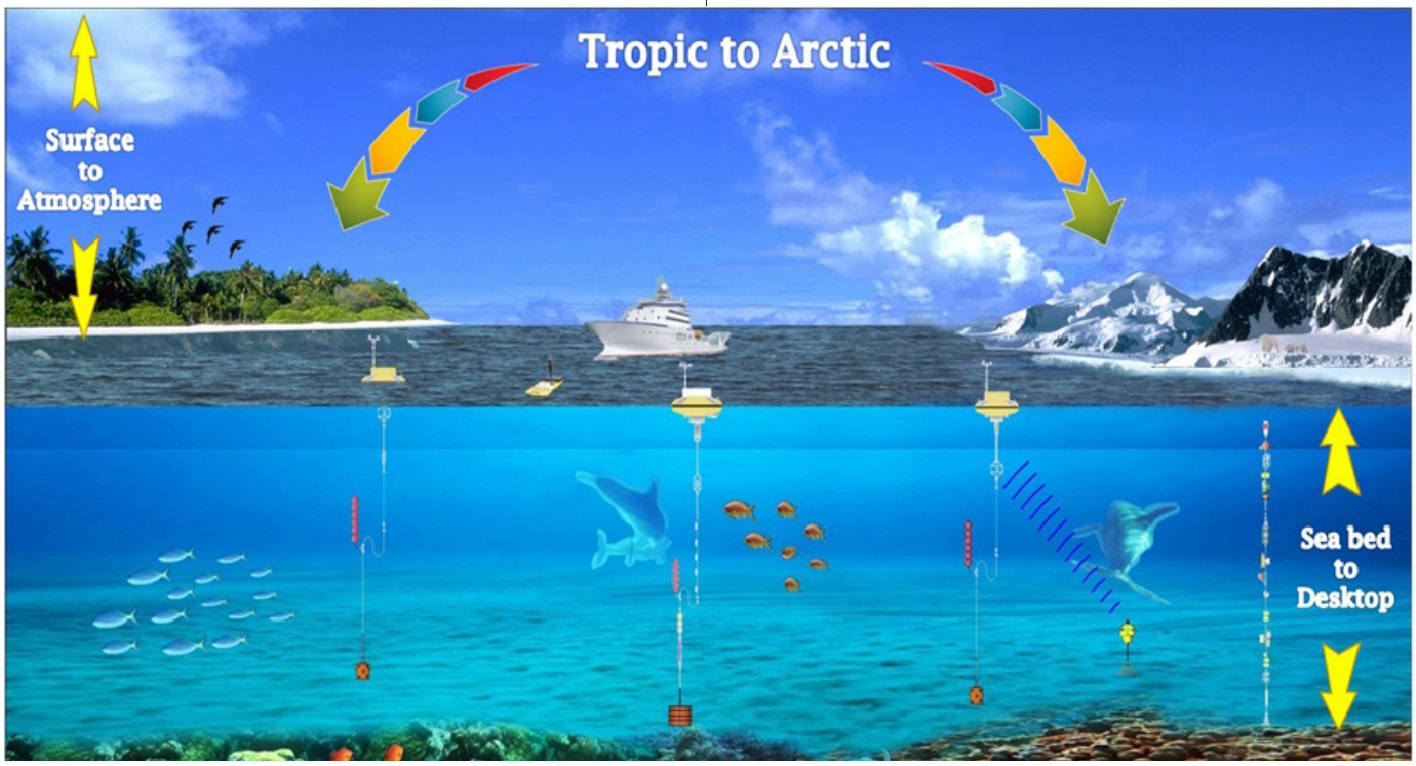


Fig. 1 Indian ocean observations foot print.

Ocean as its source of interest.

3. Characteristics of Observation

The basic characteristics of observing systems are continuous long-term measurements with strategic spatial and temporal sampling where the data continuity is sought in the observed quantity (measured parameter) which could be complemented with different measurement methods (sensor principles). Thus, following mechanisms are required to be put in place to improve the observing technologies:

i. Engineers/Technologists should understand the requirements of Researchers/scientists and work in synergy to make ocean observations more sustained, complete and effective.
ii. Continuity in observations and coordinated observing system associated with shared use of platforms like shipboard, moorings, satellite and floats etc., and data between nations or agencies.
iii. Better data management and timely release of data to users will enhance observing system capabilities.
iv. Establish formal relationships between the ocean and atmosphere communities for purposes of data.
v. Encourage the use of new technologies and compare the performance with the conventional systems.
vi. Enhance capabilities for indigenization of products to make better models & forecasts and thus improved warning systems.

4. Indian Moored Buoy observation network

Met buoy system

The ability to forecast weather and global climate changes, thus minimizing disastrous effects of events such as cyclones, storm surges and tsunamis, remains contingent on the capability to observe the changes in ocean in real-time at spatial and temporal scales with the required resolution and accuracy. In order to meet these requirements, effective planning, management, dedicated team, continuous efforts, expertise and diversified knowledge in the fields of Science and Technology are required. The sustenance of Indian Moored Buoy Network from 2010 to 2015 involves planning and execution of 70 cruises, 1293 ship-days covering 99601 nm (nautical miles, one nautical mile is equal to 1.852 kilometer) of sailing. In 1997 when this buoy technology was brought to this country 14 parameters were transmitted which is expanded to 106 parameters today.

Indian moorings use INMARSAT telemetry for the transmission of data in comparison to the other countries which use ARGOS/IRIDIUM satellites telemetry. INMARSAT consumes 8 times more power compared to Iridium and is a big challenge for the buoy systems to work uninterrupted at high seas far away from the Shore.

A national expert committee in March 2009 devised a requirement to install deep sea instrumented buoys to collect data from sub surface up to 500m similar to RAMA network with additional meteorological sensors like solar radiation and precipitation. On a global tender basis this work was accomplished and these systems are working satisfactorily since 2010 and have provided valuable newer in-sight into the understanding of air-sea interaction. Now these specialized buoys are being handled by NIOT and have this expertise now.

The data availability of one of the Coastal buoys deployed off-Andaman coast had a continuous data since its first deployment in 2011 till date. The data of water temperature is shown below.

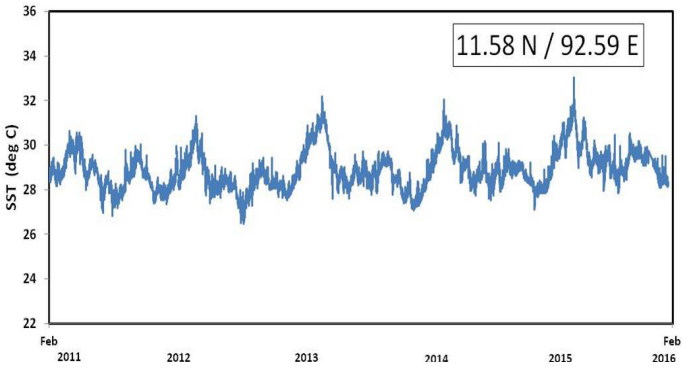


Fig. 2. Sample data of continuous data availability at Andaman 2011-2016.

Tsunami Buoy System

Tsunami buoys are being deployed with indigenous surface buoy system consisting of in-house CPU and other components built based on experience gained till now with improved techniques which helped us to improve the performance of systems. These systems are working satisfactorily and the datasets are being shared with NOAA/ NDBC, USA.

The Tsunami system consists of an anchored seafloor tsunameter, also referred to as Bottom Pressure Recorder (BPR), and a companion moored surface buoy for real time communication. An acoustic link transmits data from the BPR on the sea floor to the surface buoy and buoy to shore station through satellite telemetry. This capability is developed in house and is working successfully. Tsunami buoys with BPR are installed on seabed at depth of 3000 to 4500m. India has specialized in field expertise where such activities are done in deep sea for more than a day extending to second day in hostile conditions. So far 200 such installations have been completed without a single failure.

Integrated Marine Surveillance System IMSS

This design of IMSS received Societal Innovation award by National Research Development Corporation (NRDC), Government of India. This unique buoy apart from standard met-ocean measurements can also transmit real-time day and night video and still photographs of the surrounding environment, captured using the high resolution video cameras encapsulated to work in hostile marine environment through 3G telemetry. This is accomplished above water and could be implemented underwater also. The above facility would help to view the present sea conditions remotely, which would be more useful for the fishermen community. This buoy is also augmented with Automatic Identification System (AIS) to capture information about the ships passing by the buoy location.

5. Challenges

Ship time availability, prevailing weather conditions, huge inventories, physical activities etc., are major challenges to execute these two sets of buoys located in east and west coast of India. Vandalism of these valuable ocean data buoys has been, and remains, a significant problem in many ocean areas. The vandalism can be both deliberate (theft of equipment and

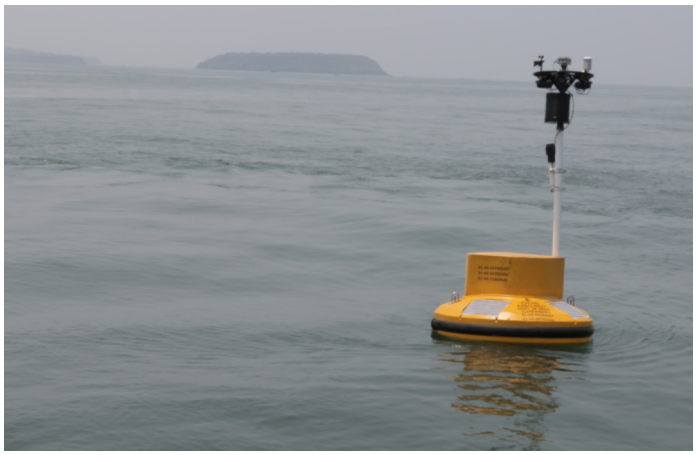


Fig. 3. Integrated Marine Surveillance System (IMSS) deployed off Goa

buoy parts, severing and theft of moorings) and inadvertent (primarily due to fishermen working too close to moorings, which are known to aggregate fish). Thus many efforts were undergone to conduct consciousness among fishermen about the buoy systems by organizing awareness programmes with lot of success. Another major challenge in the form of piracy was also observed in Arabian Sea. In order to mitigate the same, armed guards were deployed on the research vessels during the cruises for counteracting the piracy. Since 2014, Indian seas have observed a steady decline in the piracy issues.

6. Indigenous technological developments

CALVAL buoy system

The Calibration and Validation (CALVAL) buoy system deployed off Kavaratti is unique and one of its kinds in this region installed for satellite data validation in association with Space Applications Centre, Indian Space Research Organization for the calibration and validation of remote sensing data. The buoy is working successfully with INSAT communication since October 2013 providing continuous data.

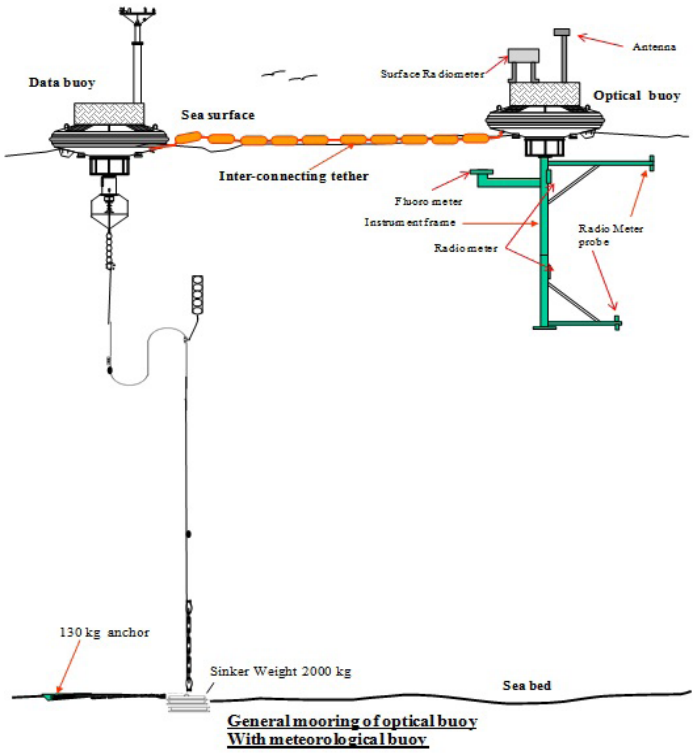


Fig. 4. Design of twin buoy system for CALVAL

IndARC

Indian Arctic Mooring (IndARC I and II) is the first underwater moored observatory deployed by India in Polar Waters on 23rd July 2014 with the support of ESSO-NCAOR at 192m water depth and it was retrieved and redeployed during July 2015 on-board Research Vessel Lance (Norwegian Polar Institute). This in-house design effort is a milestone achievement as the data acquired would be of vital importance to the Indian climate researchers and international fraternity in understanding the Arctic processes and their influence on the Indian monsoon system through climate modeling studies. Dr R Venkatesan, Mr Arul Muthiah, Dr Krishnan (NCAOR) and Mr Kesavakumar have been selected for the National Geoscience Award of Government of India. This team was responsible for IndARC

Fig. 5. IndARC Arctic Moored Observatory

Sagar Bhoomi - Indian Tsunami Buoy System

The Development of Indian Tsunami Buoy System (ITBS) –'Sagar Bhoomi' avoids the technology dependency and provides the capacity to upgrade and improve the tsunami buoy system with cost competitiveness. The development includes next Generation buoy hull, Low Power Integrated Data Acquisition Module (LIDS) and Indigenized BPR. The new buoy hull has been designed to increase the durability and improve data redundancy for Tsunami prediction. The prototype Indian Tsunami Buoy and BPR system (ITB01) – 'Sagar Bhoomi' was tested and deployed successfully in Bay of Bengal at depth of 3320m

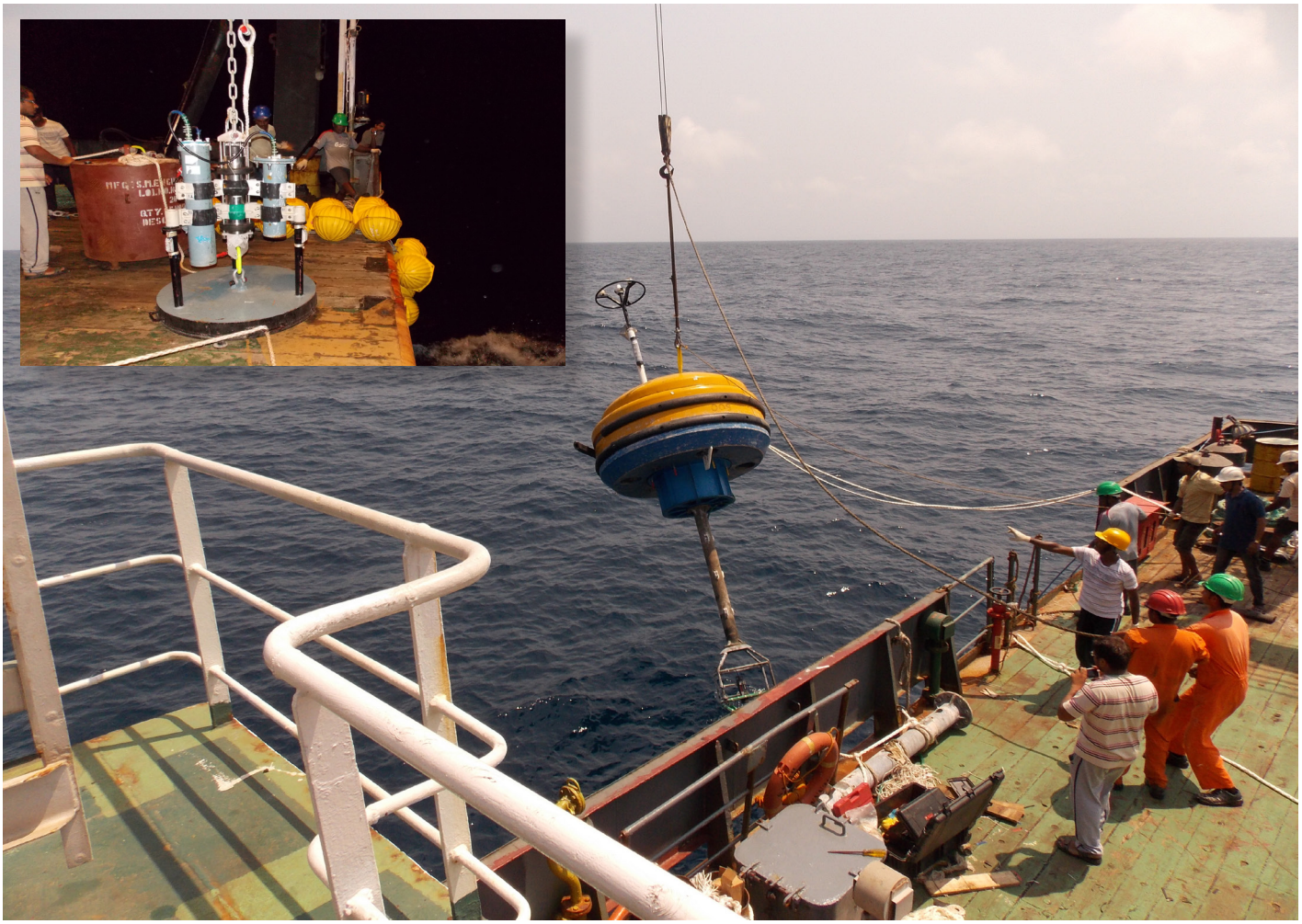


Fig. 6. Prototype Sagar Bhoomi - Indian Ocean Tsunami Buoy System

Hridaya – Data Acquisition system

In order to have self-sufficiency and not to depend on bought out technology NIOT took the mission of developing in house data acquisition system which could work continuously for more than a year requiring test protocols and selection of suitable components. This was achieved through industry initially for met ocean buoy and has been expanded to 5 more variants. This is one of the biggest achievements in indigenization process today and such system has proven to be working in different locations for more than 4 years.

Data Reception Centre

NIOT has a state of the art data reception center and has developed a data visualization tool called ADDRESS (ADvanced Data REception and analysiS System) software was developed for data visualization, analysis, watch circle for buoy position monitoring, automated QC conforming to international standards, quick bird eye view on platform configurations, inventory, history of components and cruise operations. The datasets are in different forms, obtained from three different types of buoy systems (106 parameters from Prakruti - Indian OMNI, 74 from OMNI, 34 from Met-Ocean and 25 from Tsunami buoys per transmission) both hourly and three hourly per day.

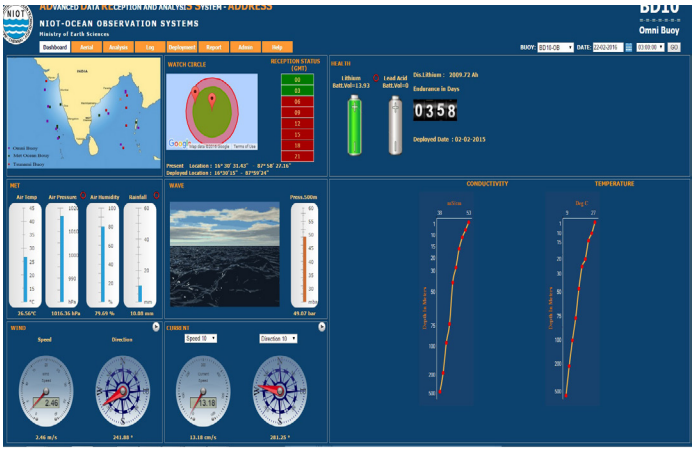


Fig. 7. ADDRESS software dashboard

7. Observation techniques

Ship-based Observation

The measurements from the vessel using tethered and non-tethered instruments are well advanced. These could be hull mounted or towed Acoustic Doppler Current Profiler (ADCP) for currents, taking samples of water to examine its properties. Even now taking measurements or samples from a ship is still the mainstay of in-situ oceanographic observations. Many different sampling systems are used from ships, but by far the most common is the use of a package consisting of a water bottle array with a Conductivity-Temperature-Depth (CTD) probe that is lowered into the ocean when the ship stops on station. The CTD rosette includes sensors for conductivity (from which salinity can be derived) and temperature plus a pressure sensor. The measurements during lowering and hauling up are called downcast and upcast and mostly downcast is preferred. Sensors that could be attached

along with Conductivity/Temperature/Depth (CTD) profilers are pH and dissolved oxygen sensors, nutrient sensors, fluorometers, transmissometers, turbidity sensors and radiometers. Water samples from the bottle array are taken to calibrate the conductivity sensors as well as to measure oxygen and its isotopes, nutrients, chlorofluorocarbons (CFCs), dissolved inorganic carbon and alkalinity, trace metals and a host of other parameters important for climate, biogeochemical and ecological studies. Most research ships are equipped with a variety of underway samplers like AWS. The sensors are mounted on the ships' masts to record marine meteorological parameters, as well as other equipment taking measurements of the ocean such as thermosalinographs (that measure the temperature and salinity of the water a couple of meters below the surface).

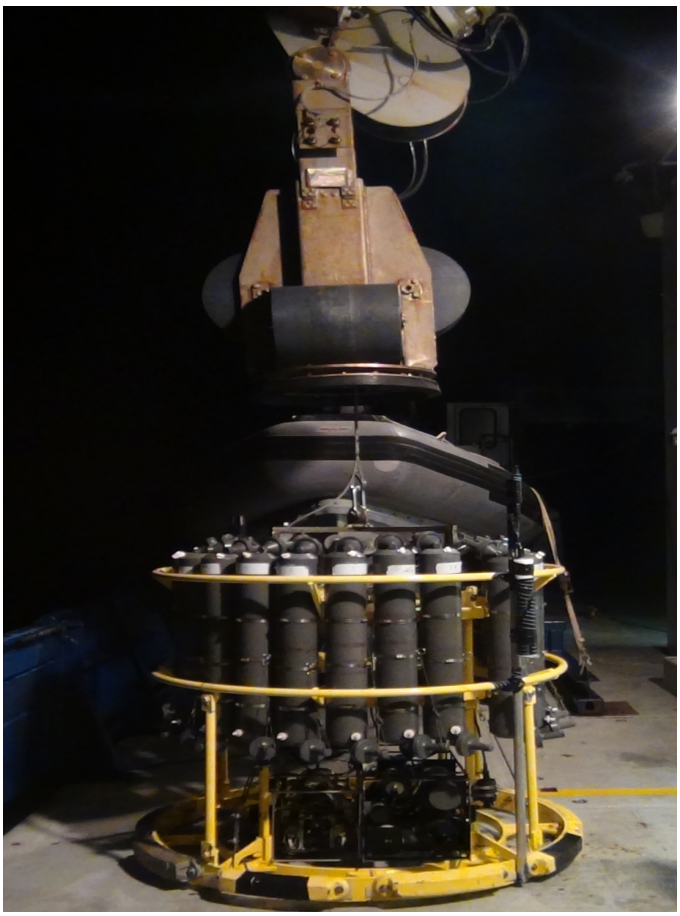


Fig. 8. Tethered instruments and CTD rosette being lowered.

Moored Buoy Systems are one of the most common platforms of Ocean Observations for cost effective means of obtaining meteorological and oceanographic data. In addition to these existing platforms, several other modes of unmanned systems have been evolved in the past decades for long term observations such as Autonomous Underwater Vehicles (AUVs), Autonomous Underwater Gliders (AUGs) and other autonomous platforms. These new observation tools can be used for long term ocean observations with minimum energy consumption and these developments are undertaken.

Gliders

Gliders are AUVs designed to glide through the ocean by changing their buoyancy. They use wings to convert the vertical velocity into forward motion. They follow therefore a sawtooth path, with a maximum angle of slope of about 30°, which is steeper than the slope of oceanographic distributions. The buoyancy of an underwater Glider depends on the salinity and temperature of the medium of travel. To change its buoyancy, a Glider must necessarily change its density (volume or mass). Since it is not practical to change the mass every time, a net change in volume is needed. This volume change is accomplished through Variable Buoyancy System (VBS). The changes in salinity and temperature of sea water and hence density directly affect the buoyancy of the vehicle resulting in a need for automatic control of the weight of the vehicle.

Fig. 9. Glider. *Source:* Webb Research Corporation, Bluefin robotics and Applied Physics Laboratory, University of Washington

The concept behind the control of the VBS is a simple mass to volume relation which affects the displaced volume of the vehicle thus controlling the buoyancy of the vehicle. Apart from the depth change, the changes in the vehicle trim due to the battery replacement; sensor exchanges and payload fitment can be taken care of by the VBS. Presently NIOT and INCOIS have gliders and have acquired specialized skills to navigate these gliders and to process data.

Gliders move through the water with typical horizontal speed of 25 cm/s, faster than most depth-averaged ocean currents, and therefore are able to navigate to programmed waypoints. In a single deployment they can obtain hundreds of CTD and other sensor profiles and velocity estimates, with a range of thousands of kilometers, over several months' time. Because of their modest speed, glider transects deviate from their designed tracks, and the long duration means that transects are not "snapshots". These basic characteristics require gliders to be deployed in numbers sufficient for resolving the scales of interest, or deployed in combination with other measurements such as moored arrays, satellite altimetry, Argo floats, XBT transects etc.

8. Capacity building

Several workshops and training programs are being organized to provide personnel with an exposure to the International arena beforehand. One of the major and successful attempts is the SAVe (Student Autonomous underwater Vehicle) competition where 10 prototypes of AUVs were developed by engineering students in India since year 2011.

9. Summary

Today many strategies have been adopted to improve observation capabilities. Many new discoveries are required to explore the depth and breadth of the ocean through newer instruments and tools. The development of the underwater systems with good endurance has been a challenge and still remains to be the same. Moored buoy system has matured and indigenous development has been successful and design capabilities made us possible to install moored observatory in arctic. These recent developments of Ocean Observation Systems received global recognition and would continue to work towards understanding the Oceans.

The ARGO program - exposing the global oceanic phytoplankton to Peta Hertz of ultrahigh frequencies?

Review

Rahul P.R.C.
Indian Institute of Tropical Meteorology, Pune

The Array for Real-time Geostrophic Oceanography (ARGO) program has been the most successful oceanographic experiment being conducted over the global oceans. 3500 ARGO floats with Omni-directional antennas emit 12.732 PHz / year, over the global oceans, while transmitting the data to the satellites. Off which, half of it (6.36 PHz) is focused on the oceanic surface directly (while remaining half into the atmosphere); though these ultra high frequency (UHF) waves cannot penetrate the ocean surface more then a few centimeters, they definitely would have considerable effect on the phytoplankton (that basically have a diameter <1-100 µm but with concentrations of 1000's to 1,000,000 per milliliter) which float on the ocean surface. Use of Uni-directional antennas (instead of Omni-directional antennas being currently used) to transmit data to the satellites would drastically cut the PHz of UHF exposure on the global oceanic phytoplankton.

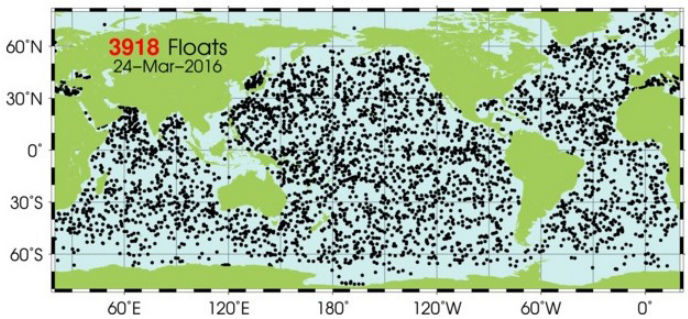


Fig. 1. The current status of Argo floats in the global ocean. Source: http://www.argo.ucsd.edu/

With the cooperation of 24 nations the Array for Real-time Geostrophic Oceanography (ARGO) program is an internationally coordinated activity with an objective of seeding the ocean with about 3900 floats (Figure 1), which gives real time temperature and salinity profiles. As UNESCO reports, the first Argo floats were deployed in late 1999, and by November 2012, Argo had collected its millionth profile of temperature and salinity, twice the number obtained by research vessels during all of the 20th century. 120,000 new profiles are collected every year, at the impressive rate of 1 profile approximately every 4 minutes. Each profile consists of up to 1,000 measurements of temperature and salinity at varying depths. A typical 10-day life cycle of an ARGO float begins with it being injected at the sea surface. Fluid in the ARGO float is pumped from an external bladder to the interior of the float reducing the buoyancy, which makes it sink and freely drift for the next 9.5 days at the predetermined depth of 1000 m, and then further sinks to 2000 m. Next, the process is reversed i.e., the fluid from the inside of the float is pumped to its external bladder, causing the float to rise while collecting temperature and salinity data. After reaching the surface, it floats for 15 hours during which the data is transmitted to the satellite (Figure 2). The results obtained, analyzed and published have helped discover new features in terms of the changing ocean dynamics in response to the climate change and also have been providing valuable oceanic data inputs that could be incorporated in the climate models to simulate realistic outputs.

The data is transmitted via the Platform Transistor Terminal (PTT) of the float, the data is transmitted omnidirectionally at UHF of 401.65 MHz with a repeativity of ~3 minutes during the 15 hours before it sinks again to start the cycle all over again. So during one month's time, the float transmits the data 3 times to the satellite for 45 hours with a UHF transmission repeativity of every 3 minutes.

Table 1: Communication concept of ARGO float

Uplink frequency (UHF)	401.65 MHz
Message length	Up to 32 bytes
Repetition period	45 to 200 seconds
Messages/pass:	Varies depending on latitude and type of service
Transmission time:	360 - 920 ms
Duty cycle	Varies
Power	Battery, solar, external

With the specifications of the data transmission method from the Table 1, it becomes evident that the UHF

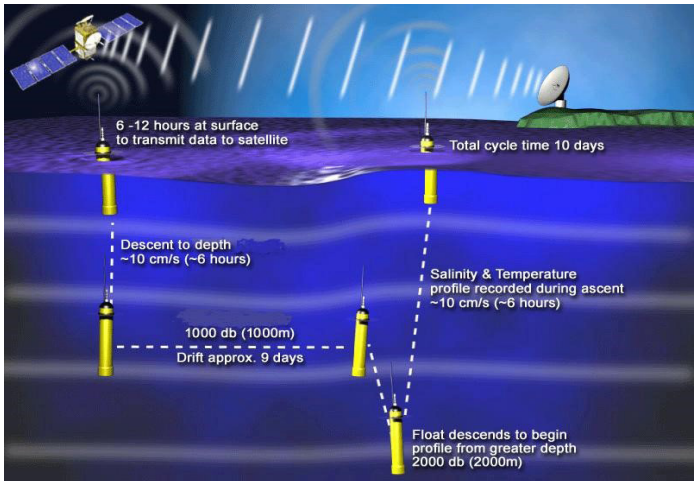


Fig. 2. Schematic of the transmission of data from the ARGO float

signal is shot of every 3.3 minutes during the 15 hour transmission time. Hence,

UHF from Single float / year:

Time	Transmitting Time	UHF
1 hour	18 minutes	7.218 GHz
15 hours	270 minutes	101.052 GHz
3 times a month	810 minutes	303.156 GHz
In one year	162 hours	3.637 THz

Therefore, the UHF from 3500 floats/year = 12.732 PHz.

Since the transmission antenna is Omni directional, it would mean that 6.36PHz UHF is exposed onto the ocean surface with the remaining 6.36 PHz is transmitted into the atmosphere. Hence cumulatively over the past 5 years a net ~30 PHz of UHF has been exposed over the global oceans with the remaining 30 PHz into the atmosphere.

The investigation of the impacts, effects of UHF on many living organisms including humans on land has been undertaken by WHO and UNEP and phenomenal publications have resulted from such investigations. The results varied with not only the increasing intensity of the UHF used in the experimentation but also most importantly on the time duration of the exposure to such electromagnetic fields[1,2]. A detailed review of the scientific evidence on dosimetry, biological effects, epidemiological observations, and health consequences (such as damage in the DNA, Cellular structure, endocrine, nervous systems) concerning exposure to high frequency electromagnetic fields (100 kHz to 300 GHz) has been published by the International Commission on Non-Ionizing Radiation Protection under auspices of the World Health organization[3]. Also, a number of marine species including fishes, marine mammals, sea turtles, molluscs and crustaceans are sensitive to electromagnetic fields and use them for e.g. orientation, migration and prey detection. In regard to effects of EMF on phytoplankton it can be concluded that there is no doubt that electromagnetic fields are detected by a number of species but their impacts on them are not clearly known i.e., chlorophyll a and chlorophyll b decreased significantly after repeated exposure to the UHF[4].

Though the UHF does not penetrate into deeper ocean surface, it does penetrate, i.e., the skin depth is few centimeters[5,6]. Phytoplankton thin layers represent regions of enhanced ecologically relevant activity, including processes such as zooplankton foraging, aggregate formation, sexual exchange, infection, and competition[7,8]. Thus in the wake of these studies that considered UHF (300MHz-3GHz) on marine life, it becomes critically important to investigate and to consider the damage what exposure to PHz of UHF would have on the phytoplankton. Results from experimentation on the impacts of EMF on the marine life are far too sparse, infact not available, but that does not mean that they do not cause damage/critical damage to the marine life. Based on the results of numerous studies that have been conducted on living beings on land, it becomes conclusive that UHF exposure does cause biological damage and its severity is proportional to the time of exposure of UHF. The ARGO float is not stationary at a point, but that does not mean that a float released in the Bay of Bengal of the Indian Ocean would drift into the Pacific, there is limitation of the drift keeping it in fixed domain. Hence even though the float is not fixed at a point (like a buoy), it is fixed over a domain in which it drifts (in this case, bay of Bengal), hence the UHF emission when integrated over a period of time is concentrated over that specific domain, Bay of Bengal. Similarly if we consider the world ocean as single unit, the emission of UHF takes on monstrous value ~6PHz being directed at the oceans, while the remaining 6PHz is shot into the atmosphere. Though the ARGO program is the best method evolved in the 21st century to map the oceans, it is also critically important to take into effects the side/direct effects of UHF on the marine life and also on the phytoplankton.

One possible solution to this problem would be to resolve the transmission mechanism, i.e., equip the floats with one-directional/unidirectional antennas rather then omnidirectional antennas, as shown in Figure 3. Thus unidirectional antennas can be automated to track the satellite passes and only then emit the data, instead of radiating it continuously for 10-15 hours, omni-directionally.

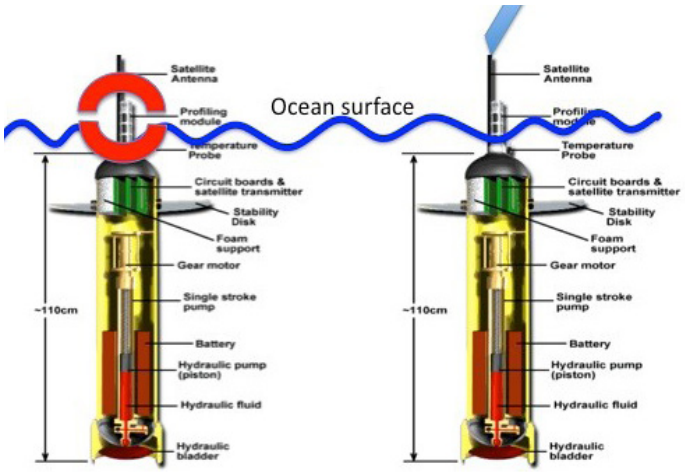


Fig. 3. Omni-directional transmission (red) of ARGO float to the satellite; right - proposed one-dimensional/uni-dimensional transmission of the ARGO float.

References:

1. AGNIR. Health effects from radiofrequency electromagnetic fields. Report of an Independent Advisory Group on Non-ionising Radiation. Docs NRPB 14(2), Chilton, NRPB; 2003.
2. Aitken RJ, Bennetts LE, Sawyer D, Wiklendt AM, King BV. Impact of radio frequency electromagnetic radiation on DNA integrity in the male germline. Int J Androl 28:171-179; 2005.
3. Paolo Vecchia et al., Exposure to high frequency electromagnetic fields, biological effects and health consequences (100 kHz-300 GHz), International Commission on Non-Ionizing Radiation Protection, ICNIRP 16/2009
4. Sandu DD, Goiceanu IC, Ispas A, Creanga I, Miclaus S, Creanga DE. A preliminary study on ultra high frequency electromagnetic fields effect on black locust chlorophylls. Acta Biol Hung. 2005;56(1-2):109-17.
5. Clark H.C., Subsurface deployable antenna array, 005, US navy report, 2010.
6. The Interaction of Radio-Frequency Fields With Dielectric Materials at Macroscopic to Mesoscopic Scales,

Volume 117, http://dx.doi.org/10.6028/jres.117.001, Journal of Research of the National Institute of Standards and Technology, 1-60, 2012.
7. Alldredge, A. L., et al. 2002. Occurrence and mechanisms of formation of a dramatic thin layer of marine snow in a shallow Pacific fjord. Mar. Ecol. Prog. Ser 233: 1–12 doi:10.3354/meps233001.
8. McManus, M. A., et al. 2003. Characteristics, distribution and persistence of thin layers over a 48 hour period. Mar. Ecol. Prog. Ser 261: 1–19 doi:10.3354/meps261001.

The Floating Potato

Science @ School

Janhavi Gopal Chougule
Std VI, Acharya Shree Vijay Vallabh Secondary School, Bhavani Peth, Pune

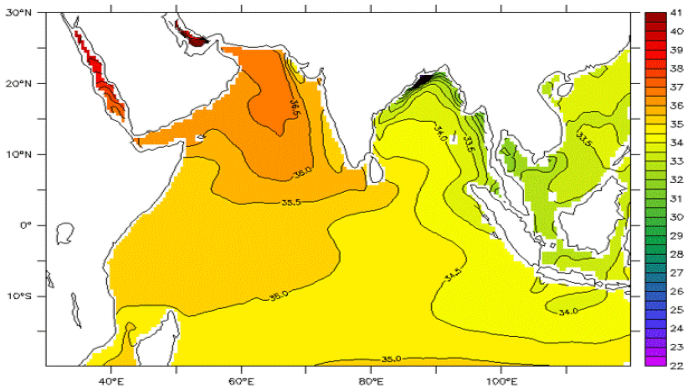
Once my friends and I were playing badminton and during the break we saw my mother preparing potato chips for us to eat. We watched that for some time and noticed that the potatoes were floating in the water. I asked my mom, why were the potatoes floating. I kept asking my Mother about that but I could not get any convincing answer. I put some chips in fresh water and to my surprise all chips settled down at the bottom of the container and then came to know from my mother that she sprinkled salt in the water. I became inquisitive and tried to find the answer to my question why do potatoes float in salty water.

I told about my experience to my Science Teacher Mrs. Deepali Tare and then she explained that Salt water has a higher density than fresh water. Salts added to the water add mass to the water in which the chips floats. I got the information of the"Dead Sea". The sea on the borders of Israel and Jordan i.e. in the Middle East, is called the Dead Sea. Immediately, I remembered that we have a lesson in our English text book. I read the chapter for more information. Nothing can survive in this salty lake, except for some microorganisms. No plants grow in it and animals can't live in it – hence the strange name, "DEAD SEA"!

The Dead Sea in fact is a lake which has no outlet and inlet. High evaporation over it leaves the salt content of this lake to 23% to 25%. In other seas, the proportion is 3.5% to 4%. Naturally, with so much salt content the density of the water of the Dead Sea is much higher than normal water and there is no danger of drowning in it. Similarly this also explained me why it is easy to swim in seawater.

Science Exhibition at the Acharya Shree Vijay Vallabj Secondary School

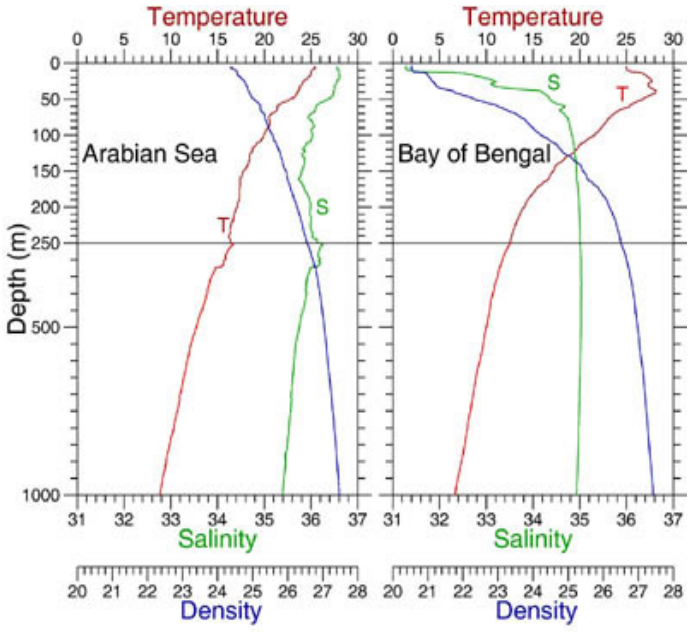
Using this principle, I put up the experiment "THE FLOATING POTATO "in the Science Exhibition. I was suggested to replace half of the salty water from the glass with the fresh water and to repeat the experiment. Interestingly the way of the floating was different from previous experiment as the salt content was reduced. This helped me to distinguish the salinity difference between Arabian Sea and Bay of Bengal. The Bay of Bengal is less saline because of the inflow of many major rivers like Ganga and Brahmaputra into the Bay of Bengal which add large amounts of fresh water, making it less salty as compared to the Arabian Sea.



Salinity in the Arabian Sea and the Bay of Bengal. Source: Vivek Shilimkar, Hokkaido University, Japan

This was well appreciated by everyone, I was extremely happy with my efforts. This has generated more interest in Science related to Ocean-Atmosphere and we will be making day to day observations of environmental parameters.

Note: The students of Acharya Shree Vijay Vallabh Secondary School, Pune have brought out an interesting experiment to demonstrate the causes of variability of salinity in the ocean basins on the occasion of National Science day exhibition held on 26 March 20016 . The article above is about a science question students attempted to answer in the science exhibition. On behalf of Ocean Society of India, Pune Chapter Dr. Milind Mujumdar preceded this science exhibition.



Temperature, salinity and density at different depths in the Arabian Sea and Bay of Bengal.

Sailors Turn Scientists and create the world's biggest citizen science plankton survey

Contributed Article

Dr. **Richard Kirby**

is a plankton scientist based of Plymouth, UK and interested in how the plankton influence the marine food web from fish to whales, and from penguins to polar bears.

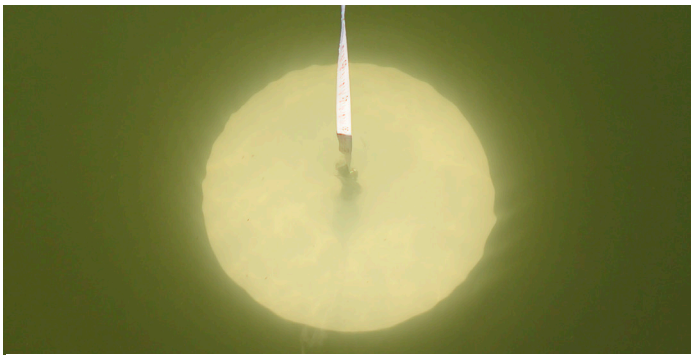
A unique global study uses a Secchi disk and a free mobile phone app called Secchi to conduct a vital global study of the sea's plankton.

In 2010 a group of Canadian marine scientists reported that the phytoplankton – the tiny plant-like cells that underpin the marine food web and colour the sea usually green – had declined globally by 40% since the 1950s. The scientists suggested that a warming of the ocean surface due to climate change had reduced the vertical mixing of the water column, thereby reducing the supply of nutrients from deeper waters – in effect the input of fertiliser to the surface had lessened to reduce phytoplankton growth. The scientist's results provoked debate as others thought they saw no change or even an increase in phytoplankton in some places. Part of the controversy stems from a lack of continuous, long-term data on the phytoplankton, the vastness of the seas and oceans, and the fact that there aren't that many marine scientists. Because of the important role played by the phytoplankton, we need to know if, how and why they are changing, and this is why sailors, acting as citizen scientists have been asked to help. Since the project's launch in February 2013 sailors have already established the Secchi Disk study as the largest, global marine citizen science study.

Secchi Disk

Lowering the Secchi Disk

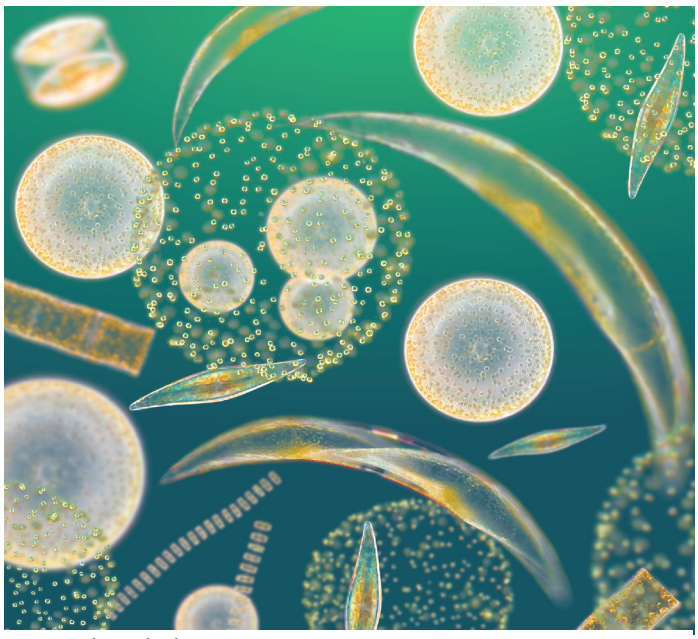
So how does the Secchi Disk study work? As the name suggests, the project uses a Secchi Disk, which is a self-made component of the study. A Secchi Disk is a round, white disk exactly 30 cm in diameter that is attached either to a fibreglass tape measure or to a marked length of rope, and weighted from below. The Secchi disk was invented by the Pope's astronomer in 1865, initially to measure the clarity of the Mediterranean to chart its currents. A Secchi disk can be made from any material, such as a white plastic bucket lid or a piece of plywood painted white. So far, sailors have been very ingenious in the materials they have used. The tape measure is held and the Secchi disk is lowered vertically into the seawater from the side of a boat (you need sufficient weight to make the disk sink vertically), and you note the depth below the surface at which the Secchi disk just disappears from sight. This number, the "Secchi Depth", reflects the transparency of the water column, which is influenced by the amount of phytoplankton in the sea. The quicker the Secchi Disk disappears from sight the smaller is the Secchi Depth and the more phytoplankton there is in the water. The Secchi Disk is a tried and tested, and a very simple tool to measure the phytoplankton.



Secchi Disk under water

Once the Secchi Depth is determined, sailors then use their smartphone and the free Secchi app to obtain their GPS location and to enter the Secchi Depth - a network connection

isn't required for this. The Secchi App then stores the data on the phone and the Secchi Disk project database receives the data as soon as network connectivity is regained. Anyone can follow the data collected on the project map.



Marine Phytoplankton

The aim of the project is to build a map that charts the seasonal and annual changes of the phytoplankton from now and into the future. It is a long-term project that carries on indefinitely. Sailors may measure the Secchi depth at the same place regularly, or occasionally, or they may take measurements from different places as they travel. The more sailors that take part the better the coverage of the oceans, and the more remarkable the database will become.

Since the initial study in 2010 that suggested the phytoplankton are declining in the oceans, other studies have also suggested that the phytoplankton are declining due to climate-induced changes in their sea surface habitat. The most recent of these entitled "A reduction in marine primary productivity driven by rapid warming over the tropical Indian Ocean" has just been published in the Journal Geophysical Research Letters. In this paper led by author Roxy Mathew Koll from the Indian Institute of Tropical Meteorology, data is presented demonstrating a decline in phytoplankton in the western Indian Ocean by up to 20% over the last 60 years. Interestingly, the western Indian Ocean shows the largest warming trend among the tropical oceans and the study's authors found the downward trend in phytoplankton could be explained by a reduction in nutrients reaching the surface form deeper waters due to increased stratification of the water column. Clearly, studying the phytoplankton is of current importance.

Dr Richard Kirby, the Secchi Disk project leader says: "Often we look back and wish we had already started monitoring something about the natural world - if only we had started measuring 'x' some years ago. Our view was there is no time like the present to start something for the future. This is why we created the Secchi App and this citizen science project for seafarers, to try to encourage global data collection on the phytoplankton and to make data submission simple."

In just 3 years the Secchi Disk study has become the world's largest marine citizen science study. Participants include sailors, divers, school children with access to boats, and small boat commercial fishermen. The project not only collects important data on the phytoplankton but is also a gateway to learning about the smallest of marine life that lives at the sea surface. Why not take part ?

You can find the Secchi Disk project at its website www.secchidisk.org, on Facebook www.facebook.com/secchidisk and on Twitter @secchiapp.

Secchi App

Indian Oceanographic Satellites -A Review

History Article

Rashmi Sharma and C.M. Kishtawal
Atmospheric and Oceanic Sciences Group,
Space Applications Centre,
Indian Space Research Organization, Ahmedabad

Satellite Oceanography includes oceanographic research and technological development resulting from data obtained from satellite systems in Earth's orbit, exploiting the ocean's interaction with electromagnetic radiation (visible to microwave). These systems observe and measure oceanographic parameters such as sea surface winds, sea surface temperature (SST), ocean waves, sea surface salinity (SSS), sea surface height (SSH) and ocean colour. These

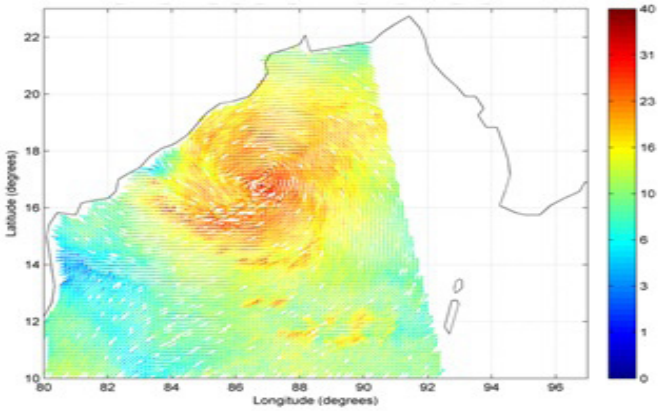


Fig. 1. Phailin cyclone as seen in 12 km OSCAT wind (m/s) data.

parameters undergo thorough assessment using in situ data, what is known as calibration/validation, before they are used for operational and research needs. These variables are the backbone of operational oceanography and also play key role in understanding Ocean's role in weather and climate. Satellite data also helps in understanding the dynamics of ocean surface currents, mesoscale eddies, its lifecycle and their interaction with the large scale processes. Monitoring the evolution of basin-scale phenomenon such as El Nino and Indian Ocean Dipole has been possible with the advent of satellites measuring SSH and SST. These observations are

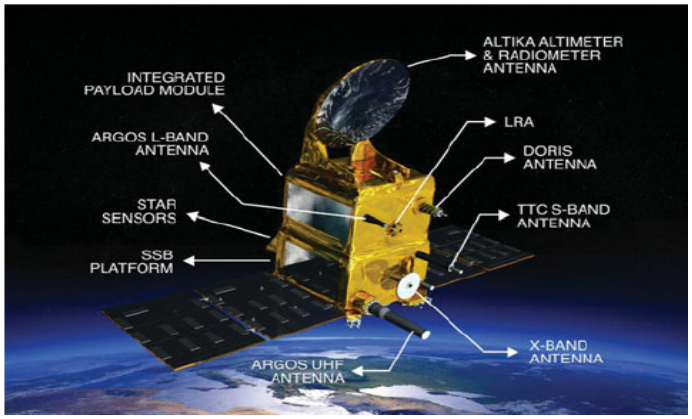


Fig. 2. SARAL AltiKa. *Source*: Verron et al. 2015

assimilated in the numerical ocean models to improve the initial conditions for accurate ocean state prediction a few days in advance. Ocean state predictions are extremely useful for naval operations and shipping industries apart from many other uses.

India's tryst with oceanographic satellites started way back in 1979 with experimental missions, Bhaskara I (1979) and II (1981) carrying satellite microwave radiometer operating at three frequencies. IRS -P3 carrying German-built eighteen channel Modular Opto-electronics Scanner is the first in the series aimed at oceanographic research. The data from these provided momentum for scientific investigations. Data at high radiometric resolution and at narrow spectral bands were used to retrieve ocean colour and atmospheric parameters. However, small swath (200 km) and 24 - day repeativity prevented it from the use of operational applications. IRS-P4 (Oceansat - I) carrying two payloads Ocean Colour Monitor (OCM) and Multi-frequency Scanning Microwave Radiometer (MSMR) was launched in 1999 which contributed immensely in ocean and atmospheric research. Oceansat - II carrying active microwave sensor, scatterometer (OSCAT) and OCM was launched in 2009. Wind observations from OSCAT were routinely assimilated in to weather models for providing accurate weather prediction and were used for variety of applications, cyclones (Figure 1) to sea state studies. Several parameters are being derived from OCM, like diffuse attenuation coefficient, suspended sediment, chlorophyll concentration, which is helping scientists to study the biological processes and also coupled bio-physical processes. Another microwave sensor, Altimeter (AltiKa) onboard SARAL (Figure 2) in the framework of collaboration between ISRO and CNES was launched in the year 2013. It has already completed several revolutions in its orbit. AltiKa operates in Ka-band. This is the first time that high frequency altimeter has been put in orbit.

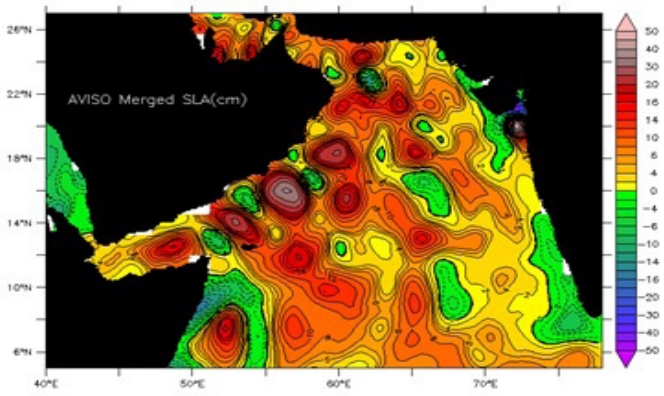


Fig. 3. Mesoscale eddies from merged altimeter in the Arabian Sea on 27th June, 2014.

The small footprint in Ka-band has been highly beneficial for coastal and inland water applications. This instrument along with contemporary altimeters have been remarkably successful in several studies, ranging from ocean state prediction to studies of mesoscale eddies (Figure 3). INSAT-3D (Figure 4), though primarily designed for atmospheric applications and forecasting, provides SST, which is a very useful parameter for ocean applications and air sea interactions. Half hourly SST data at a resolution of 4 km provided by INSAT-3D is extremely useful for studying the oceanic thermal fronts, its dynamics and effect on air-sea interaction. High resolution imagery from synthetic aperture radar onboard RISAT-1 has a potential to reveal sub-mesoscale features and internal waves. ISRO has planned several missions for ocean-atmospheric research. SCATSAT scatterometer, Oceansat-3, imaging radar NISAR (dual frequency Synthetic Aperture radar in collaboration with NASA) and GISAT (high resolution SST) will be all very useful for ocean research.

The new concept of 'constellation of satellites' is fast emerging as a trend, where various space agencies coordinate their missions to achieve maximum benefit. This in turn helps in improved understanding of ocean, weather and climate at various temporal and spatial scales. Need for new sensors such as LIDAR and multi-frequency, multi- polarization synthetic aperture radar are constantly being reviewed. Another very important emerging concept is making use of opportunity signals from regional navigational systems, which has immense potential for ocean research. India's own regional navigation system, IRNSS hold promise in this regard.

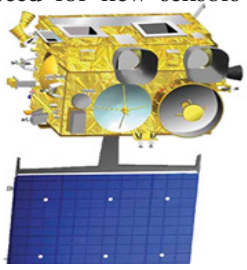


Fig. 4. INSAT 3D

Coastal upwelling process and its simulation using numerical ocean model

Student Article

Tanuja Nigam* and Vimlesh Pant
Centre for Atmospheric Sciences,
Indian Institute of Technology Delhi, New Delhi
Email: tanujanigam88@gmail.com

Upwelling is an important oceanic phenomenon in which subsurface cold and nutrient enriched water from depth about 100-200 m rises near to the surface and enhances biological productivity and therefore, affects the regional coastal climate. Coastal upwelling generally occurs when surface alongshore wind blows equatorward (poleward) along the eastern (western) boundary of an ocean. Ekman [1905] introduced the basic mechanism of wind forced upwelling by observing the deflection in the drift of icebergs. The observed deflection can be explained by the balance between the wind frictional force and Coriolis force, caused by Earth's rotation. Horizontal divergence at the surface layer caused by Ekman transport is responsible for the ascending motion from the subsurface layers due to convergence below. Further, Sverdrup [1938] defined the upwelling process as an ascending motion by which water from deeper oceanic layers is brought to the coastal surface and is shifted away by a horizontal flow. As wind blows, the upper most layer of water gets pulled along in the same direction of the wind, and deflected by 45° to its right (left) side in the northern (southern) hemisphere due to the Coriolis force. The subsequent layers in ocean get further deflections with reduced velocity with increasing depth. Eventually, there is a depth where the effect of the wind is not felt, called the Ekman Depth. Ekman depth is also defined as the depth where the current direction reverses to that of surface current. By averaging all the movement of the water from the surface to the Ekman Depth, Ekman Transport is derived. The net Ekman transport is 90° to the wind direction and towards right in the northern hemisphere. Sverdrup [1942] found that the Ekman transport is proportional to the wind curl and inversely proportional to the sine of the latitude. Stommel [1958] named the upward (downward) positive (negative) vertical velocity (Wek) that is associated with the bottom Ekman layer as the Ekman suction (Ekman pumping).

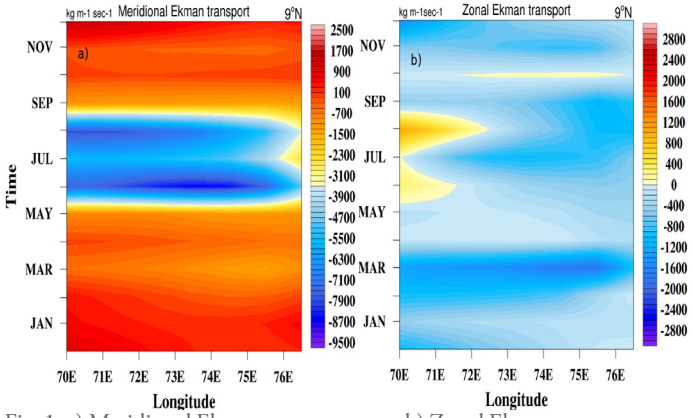


Fig. 1. a) Meridional Ekman mass transport b) Zonal Ekman mass transport (in kg m^{-1} s^{-1}) along 9° N latitude at the west coast of India.

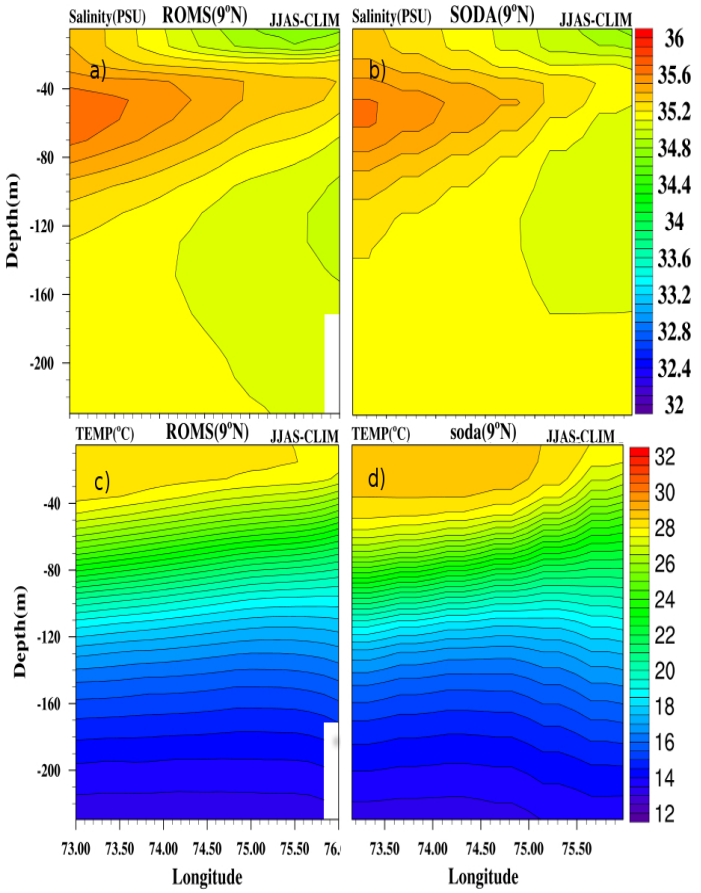


Fig. 2. (a) Model simulated salinity profile (psu), (b) SODA salinity profile, (c) Model temperature profile (°C), (d) SODA temperature profile along 9° N latitude at the west coast of India.

The wind driven horizontal surface layer divergence in ocean is the primary cause of upwelling process. However, the nature of interactions between wind stress, lateral and vertical mixing, waves, and eddies are not well understood. Upwelling can be of three types, namely coastal upwelling, equatorial upwelling, and open ocean upwelling. However, the coastal upwelling is most abundant out of these three categories and has more scientific interest due to its economical and societal impacts. About half of the fish-production occurs in the shelf regions where coastal upwelling takes place. Some of the climatic events such as El Niño and Tropical Atlantic variability can cause variations in upwelling strengths at various coasts.

During the Indian summer monsoon (June-September), the strong southwesterly winds blow over the northern Indian Ocean (NIO), producing upwelling at the coasts of Somalia, Oman, Arabia and the west coast of India. The coastal upwelling feature at the Somalia coast originates during late April to early May, peaks in July to August, and continues up to early October. Off the southwest coast of India, upwelling is noticed during summer monsoon months from May to September. Upwelling signals are observed in sea level from February onwards [Shenoi et al., 2005]. Rao et al., [2008] using Princeton Ocean Model (POM) reported that the upwelling processes initiated on the southern part of west coast of India in March and slowly propagates northward to cover the entire coast by September but the maximum degree of upwelling was observed off Kerala coast in July.

In the present study, coastal upwelling features off west coast of India were simulated using a hydrostatic, free

surface, primitive equation ocean model 'Regional Ocean Modelling System' (ROMS). The ROMS model is forced by monthly climatological forcing from Comprehensive Ocean Atmosphere Data Sets (COADS). The model follows sigma coordinate in the vertical. The horizontal and vertical resolutions of model are 0.16° × 0.16° and 40 vertical levels, respectively. The zonal and meridional Ekman transport was calculated using the daily climatological TropFlux wind Stress data. The upwelling favourable negative zonal Ekman transport near the coast was observed during the southwest monsoon season off the west coast of India, (Fig. 1). The model simulated temperature and salinity profiles were validated with Simple Ocean Data Assimilation (SODA) data. In general, the model simulated sea surface variables (temperature and salinity) were in good agreement with the observations. Model was able to simulate the climatological southwest monsoon upwelling features off west coast of India. Simulations showed that the upwelling features off west coast starts establishing in the month of May, peaks in August and subsequently the upwelled cold water advects northward. The meridional (Mev) and zonal (Meu) Ekman transports are calculated using following formula:

$$M_{eu} = \frac{\tau_y}{f} \quad and \quad M_{ev} = \frac{-\tau_x}{f}$$

where f is Coriolis parameter, τx and τy are the zonal and meridional wind stress, respectively.

References:

1. Ekman, V.W. (1905), On the influence of the Earth's rotation on ocean currents. Arkiv for Matematik, Astronomi, och Fysik 2 (11) 1–52.

2. Rao A. D., Madhu Joshi, M. Ravichandran (2008), Oceanic upwelling and downwelling processes in waters off the west coast of India, Ocean Dynamics, 58:213–226, DOI 10.1007/s10236-008-0147-4.

3. Shenoi S.S.C., D. Shankar, V.V. Gopalakrishna, and F. Durand (2005), Role of ocean in the genesis and annihilation of the core of the warm pool in the southeastern Arabian Sea, Mausam, 56, 147-160

4. Stommel H. (1958), The abyssal circulation. Deep Sea Res. 5, 80-82.

5. Sverdrup H. U. (1938), On the process of upwelling, Journal of Marine Research, V.I, 155 – 164

6. Sverdrup, H.U, M.W Johnson, and R.H Fleming (1942), The Oceans: their physics, chemistry and general biology, Prentice-Hall Inc., 1087 p.

Quantum Information Processing

Contributed Article

Manoj Kumar Tandon
Visiting Faculty, Savitribai Phule Pune University (SPPU), Pune.
Symbiosis International University (SIU), Pune. Centre for Advanced Training in Earth System Sciences and Climate, Pune
Centre for Atmospheric Sciences,
Indian Institute of Technology Delhi

No matter how large classical digital computers become, there will always be some calculations that are too large for them to compute in reasonable time. Hoping to circumvent these limitations, physicists have begun in the past few years to seriously entertain the possibility that a radically different type of processing could solve certain kinds of problems that a classical digital computer could not solve in the lifetime of the universe. Called "Quantum Information Processing" it harnesses the often non intuitive quantum properties of individual atoms and photons to store and process information. In silicon based classical digital computers of today, a bit is a fundamental unit of information, classically represented as 0 or 1. A document of n characters is stored as a string of 8n bits in today's digital information processing. Herein lies a key conceptual difference between classical and quantum information processing. Whereas the classical digital information processing obeys the well understood laws of classical physics, a quantum information processing harnesses physical phenomenon unique to quantum mechanics in general, and quantum interference in particular, to realize a fundamentally new mode of information processing. In quantum information processing, the fundamental unit of information is quantum bit or qubit. Unlike classical bit, a quantum bit (qubit) is not binary but rather more quaternary in nature. The qubit property arises as a direct consequence of its adherence to the laws of quantum mechanics which differ radically from the laws of classical physics. A qubit can exist as a state corresponding to the logical state 0 or 1 as in classical bit, but also in states corresponding to a blend or coherent superposition of these two classical states. In other words, a qubit can exist as a zero, a one or simultaneously as both zero and one, with a numerical coefficient representing the probability for each state. This may seem counterintuitive because everyday phenomenon is governed by classical physics and not by quantum mechanics. Concept of quantum parallelism is inherent in the philosophy of quantum information processing. Quantum information processing is a novel way to incorporate physics into computers. Quantum information processing has arisen in response to a variety of converging scientific challenges. Classical digital computers are around since long but quantum computers are the most recent development. Different groups of quantum physicists and computer scientists are currently working on the development of effective and efficient quantum algorithms, quantum cryptography and quantum hardware. Silicon and semiconductor phenomena have long since dominated the classical digital computer design and hardware, now we shift gears and come around with a totally new computer unknown to our predecessors.

Niels Henrik David Bohr (1885 – 1962 :

Danish Physicist), the physicist who made fundamental contributions in apprehending quantum theory once stated that "if quantum mechanics hasn't profoundly shocked you then you haven't understood it". Quantum mechanics is a development in theoretical physics that occurred in the twentieth century. Quantum theory has from the beginning challenged common-sense intuition. Quantum computation involves manipulation using the rules of quantum mechanics which offer a much richer environment and allow researchers to solve problems that are intractable using the classical laws of physics. Combining computer science, physics and mathematics, quantum information processing has set forth solid foundation in moving big steps towards future of computing. The idea of a computational device based on quantum mechanics was first explored in 1970's and early 1980's by physicists and computer scientists. Richard Philips Feynman (1918 – 1988 : American Physicist) of California Institute of Technology was among the pioneers in the field of quantum information processing.

Quantum computation has its origins in highly specialized fields of theoretical physics. The subject of quantum information processing brings together ideas from classical information theory, computer science and quantum physics. In quantum information processing, each of the two classical digital bits 0 and 1 are conceptually and technically represented as wave like patterns. One kind of wave pattern represents the classical bit one and another kind of wave pattern represents the second classical bit zero. Dual nature of a qubit is technically achieved and implemented through the coherent superposition of these two different wave patterns. Mathematically a qubit represents a state in two dimensional Hilbert space. A qubit remains in an indeterminate state until it is observed, like a tossed coin that is still spinning. In classical information processing, value of a variable is internally represented by a string of bits where as in quantum information processing a wave packet will be the internal representation of the value of a variable. Classical computers brought the era of computers working for humans while quantum computers will herald an era of computers working like humans. Tactful synergy of quantum information processing and artificial intelligence will help the mankind to have a computing device which may, to a large extent, be an exact replica of human. Blending of quantum information processing and artificial intelligence may show us a day in the near future when a human will operate a technology driven human replica. In a nutshell, quantum information processing can more precisely be defined and described as "non classical information processing that is based on quantum logic to do intrinsically parallel computations on quantum information in the form of quantum states of qubits". 'Quantum Information Processing' is the fusion of physics and computer science. Communication and computing are the heart of information processing whether classical or quantum. With quantum information processing scientists and researchers are taking macro to the micro level; they are taking the phenomena of the universe to the chips in the computer. Quantum computing is not well suited for tasks such as word processing and email, but is ideal for tasks such as cryptography, modeling and indexing of very large data bases. In physics and computer science, quantum information is information that is held in the state a quantum system. Quantum information is the basic entity that is studied in the growing field of quantum information theory and manipulated using the engineering techniques of quantum information processing. Much like classical digital information can be processed with digital computers, transmitted from place to place, manipulated with digital algorithms and analyzed with the mathematics of digital computer science, so also analogous concepts apply to quantum information. Physicists and computer scientists began to investigate how the properties of quantum super positions might be applied to computing. The intrinsic complexity of quantum information ensures that quantum systems of modest size are endowed with truly vast computational power, so that a quantum computer acting on just hundreds of qubits is capable of performing tasks that could never be performed by conventional classical digital computers.

Erwin Rudolf Josef Alexander Schrodinger (1887-1961 : German Physicist), Louis de Broglie (1892-1987 : French Physicist) and Werner Karl Heisenberg (1901 – 1976 : German Physicist) are notable scientists who made outstanding and pioneering contributions in quantum theory. Famous Schrodinger equation is universally acknowledged as backbone of quantum mechanics in the domain of non-relativistic dynamics. Heisenberg's 'Uncertainty Principle' is widely acclaimed in quantum theory. Quantum computing has been a theoretical and speculative field. Quantum computing is a kind of imagination where instead of millions of desktops working side by side there is rather just one working on the same problem. Quantum computing also known as atomic computing is the research area persistent on development of computer technology based on quantum theory and principles. Quantum principles offer inherent un-paralleled parallelism. Development of quantum computer would mark a leap forward from abacus to modern day classical digital supercomputer.

By following the laws of quantum physics, the quantum computer would gain huge processing power. Field of computing technology too has been exploring the use of quantum theory into creating environment that is more and more efficient. Scientists are currently doing research on (1) Quantum Internet, (2) Quantum Machine Learning, (3) Quantum Chips, (4) Quantum Computer Networks, (5) Quantum Cryptography, (6) Quantum High Performance Computing (QHPC), (7) Quantum Artificial Intelligence and (8) Quantum Algorithms. D-Wave Systems Inc is a quantum computing company (founded in 1999) based in British Columbia, Canada. D-Wave's quantum computers are called D-Wave Systems such as D-Wave's Onion Quantum Computer. Quantum computing has created a new class of algorithmic problems in the complexity theory. From the material science to data base search to optimization problems, the impacts of quantum computation are as varied as they are transformational. The exponential changes in the science of numbers and computing techniques have made mankind scale newer heights. Albert Einstein (1879 – 1955 : German Physicist) also made pioneering and significant contributions in quantum theory. Einstein received the 1921 Nobel Prize in physics.

The principles of quantum physics are now being applied in on increasing number of areas including information technology and quantum computing. Furthermore, having achieved maturity level when it comes to information technology arena, the focus for scientists across the globe has shifted to making cloud-based transactions more secure by applying quantum theory concepts. Two of

the 20th century's most powerful ideas, quantum mechanics and computer science, are uniting into a yet more powerful body of knowledge, giving birth to new technologies and applications in a wide variety of domains. The future of quantum information processing appears bright in spite of many challenges and overcoming these challenges will probably also advance basic research. A group of Chinese scientists plans to create a 'Quantum Space Communications System' first time ever by launching a satellite that could facilitate quantum transportation of photons between earth and outer space. This could potentially facilitate super-fast, long-range communications as well as lead to the creation of world's first unbreakable quantum communications network. Physicists and computer scientists are uncovering the reality of the microscopic world and harnessing the power of quantum information processing to create new generation technologies that promise to transform our world.

News and Views

Recent Updates

NASA maps El Niño's shift on US precipitation
This winter, areas across the globe experienced a shift in rain patterns due to the natural weather phenomenon known as El Niño. A new NASA visualization of rainfall data shows the various changes in the United States with wetter, wintery conditions in parts of California and across the East Coast. [Read More]

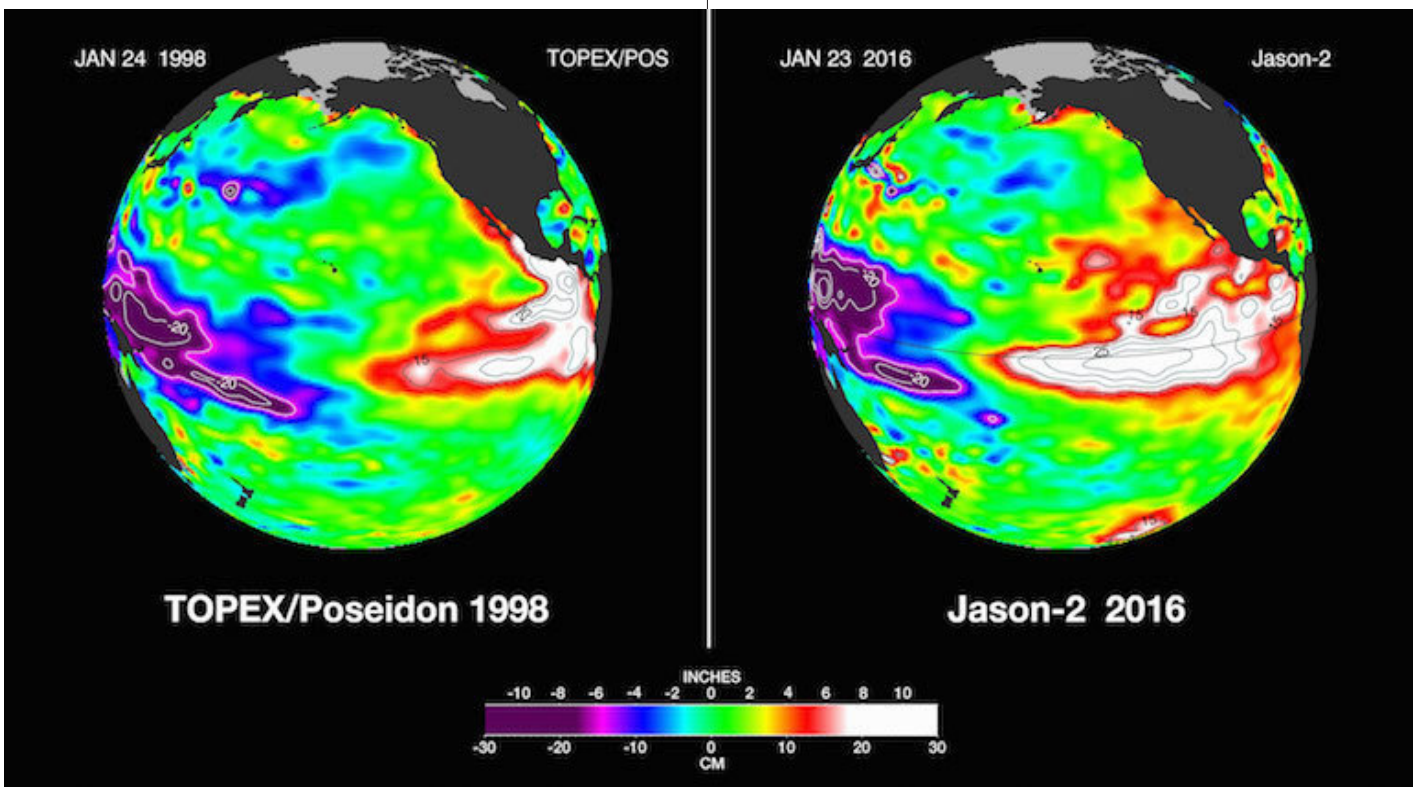
Tropical fires fuel elevated ozone levels over western Pacific Ocean
Scientists have observed the anomaly in ozone concentrations in the past, theorizing that the ozone had descended from a higher layer of the atmosphere called the stratosphere, where the air is dry and ozone acts as a protective layer, since it blocks harmful ultraviolet radiation from reaching Earth's surface. [Read More]

Jason-3 launches to monitor global sea level rise
Jason-3, a U.S.-European oceanography satellite mission with NASA participation that will continue a nearly quarter-century record of tracking global sea level rise, lifted off from Vandenberg Air Force Base in California on Sunday January 19, 2016 at 10:42 a.m. PST (1:42 p.m. EST) aboard a SpaceX Falcon 9 rocket. [Read More]

Tracing deep ocean currents
Radioactive isotopes typically take four years to reach the Norwegian coast from Sellafield on the north-eastern coast of England. Researchers like Yongqi Gao follow the radioactive waste to understand how ocean currents are formed and to see where they flow. [Read More]

New climate model better predicts changes to ocean-carbon sink
The relationship between our future carbon dioxide emissions and future climate change depends strongly on the capacity of the ocean-carbon sink. That is a question climate scientists have so far been unable to answer. In a new paper, a research team describes the best modeling approach to date for arriving at an answer to this and other crucial climate questions. Read More: Galen A. McKinley, Darren J. Pilcher, Amanda R. Fay, Keith Lindsay, Matthew C. Long, Nicole S. Lovenduski. Timescales for detection of trends in the ocean carbon sink. Nature, 2016; 530 (7591): 469. [Read More]

NASA sees a different kind of El Nino
A new NASA visualization shows the 2015 El Niño unfolding in the Pacific Ocean, as sea surface temperatures create different patterns than seen in the 1997-1998 El Niño. Computer models are just one tool that NASA scientists are using to study this large El Nino event, and compare it to other events in the past. [Read More]



El Niño 2015/16 as compared to El Niño 1997/98. *Source*: NASA.

OSI News

- Dr. R. Venkatesan, author of the invited article in the current issue of Ocean Digest, and an OSI Member, has been elected as a Steering committee member of GOOS of UNESCO IOC for ASIA/OCEANIA. He was also elected as the Chair of International Tsunameter Partnership. Dr R Venkatesan (NIOT), Mr Arul Muthiah (NIOT), Dr Krishnan (NCAOR) and Mr Kesavakumar (NIOT) will be receiving National Geoscience Award from the Honourable President of India on 5 April for the Arctic observatory.

- Dr. Roxy Mathew Koll has been selected as a member of the CLIVAR Indian Ocean Region Panel for the period 2016-2018.

- Dr. Vinu Valsala has been selected as Indian National Young Academy of Science (INYAS) Member of Indian National Science Academy for the period of 2016-21.

Conferences

Upcoming Events

- Joint Satellite Meteorology, Oceanography and Climatology Conference and Conference on Air-Sea Interaction from 15th August- 19th August 2016 at Madison, United States. [See More]

- World Conference on Climate Change (Climate Change 2016) during Oct 24-26, at Valencia, Spain. [See More]

- Eighth International Conference on Climate Change: Impacts & Responses at VNU University of Science (HUS), Vietnam National University (VNU), Hanoi, Vietnam during 21-22 April 2016. [See More]

- Indian Ocean IOC meeting to be held in Chennai during 25 to 27 April 2016.

Opportunities

Job/Fellowship Opportunities

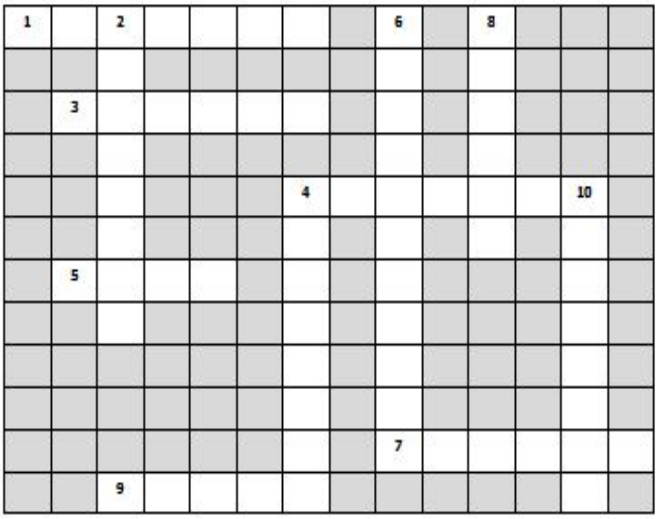
- Data Assimilation in Earth System Models - Postdoc position available at University Bonn, Germany. [See More]

- Model Developer at UBIMET, Vienna/Austria in the field of severe weather. [See More]

Send your correspondence and contributions to:
OSI Pune, Indian Institute of Tropical Meteorology, Pashan, Pune 411008, India.
seelan@tropmet.res.in
www.oceansociety.in/oceandigest/

Crossword

The clues for the Earth Science Crossword can be traced to the present and previous issues of Ocean Digest. Enjoy.



ACROSS

1. Majority of eddies are found in this boundary regimes of the oceans
3. A stationary water wave usually caused by strong winds, pressure changes, or seismic activity
4. In 1815 the Year without the summer was caused by the eruption of Mount
5. A deposit of sand-sized windblown material is known as
7. The longest direct measurements of atmospheric CO2 from a ground-based station is available from Mauna Loa, situated at this Island
9. A seismic fracture across which lateral motion occurs

DOWN

2. A unit to measure the volumetric rate of transport of ocean currents.
4. The interval of time preceding sunrise and following sunset during which the sky is partially illuminated
6. An accelerometer that records earth motions
8. The old and stable part of the continental lithosphere is better known as
10. This bottom water is the densest in the world ocean

Compiled by Bhupendra B. Singh, IITM