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Analyzation of Ocean Information through Argos

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Abstract: The ARGOS service was launched in 1978 and is geared towards environmental applications, including oceanography, wildlife tracking, fishing vessel monitoring and maritime safety. The system allows for worldwide, real-time data collection and positioning of Platform Terminal Transmitters (PTTs). Argos platforms, like Argo floats, automatically transmit messages which are received by satellites and relayed to Argos processing centres to compute a transmitter's location.

1. INTRODUCTION

Argos is a satellite-based system which collects Environmental data from autonomous platforms and Delivers it to users worldwide. Argos has truly global Service and is fully integrated - providing data from the source to the User's desktop. Telemetry from User platforms is also used to calculate geographic Position. Currently, approximately 6,000 transmitters are operating in a variety of applications involving either study of the earth or protection of the environment. The Argos system involves three interactive Subsystems:

1) Platform Transmitter Terminals (PTTs)
2) The Space Segment
3) The Ground Segment

1.1 Platform Transmitter Terminals (PTTs)

Argos operation begins with transmissions from PTTs attached to sensor equipment and the platform from which data is collected. PTTs have been adapted for applications as diverse as tracking migratory birds (i.e.,miniaturized,figure1.1) to Monitoring ice floes in harsh environments.

Figure1.1 Miniaturized PTT

Typically, they are built rugged to withstand punishment, both expected and unexpected (figure 1.2).

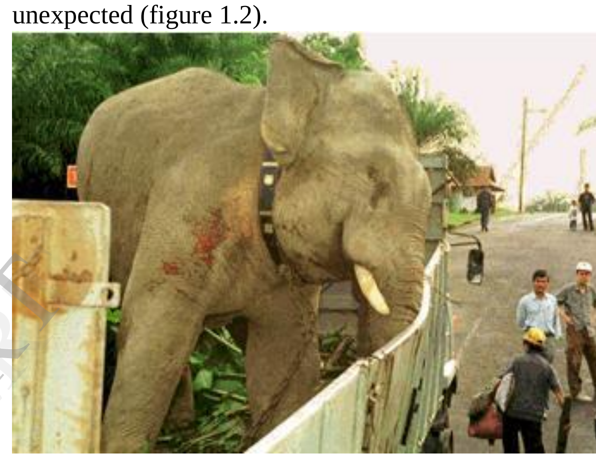

Figure1.2. Rugged Construction

Transmitters are interfaced with sensors on moored or drifting buoys (figure 1.3), animals, ships, containers, balloons, and many other platforms. They are configured by size, weight, power consumption, and housing according to application. The smallest PTTs, used to track birds, weigh as little as 17 grams.

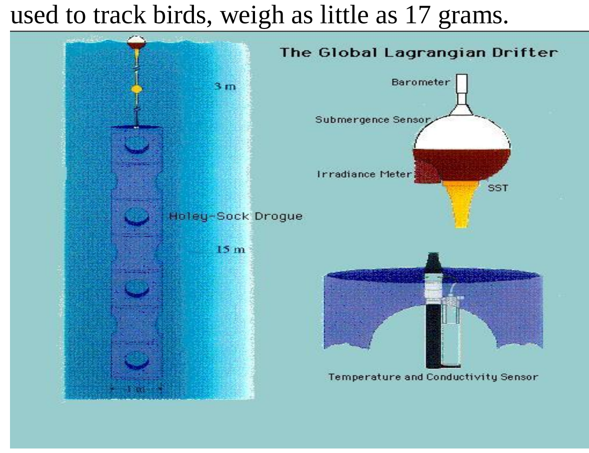

Figure1.3. Buoy w/Sensors

Power consumption on all PTTs is low due to the satellite's low-earth orbit and highly sensitive receiver equipment. This enables extended operation —a year or more— on battery power alone. PTTs Uplink (transmit) their message at preset intervals without interrogation by the satellite. Each message may contain up to 256 bits of sensor data. A full message uplink takes as long as 960 milliseconds. The uplink "time-out" or repetition period is normally set between 45 and 200 seconds, depending on the application. Although all PTTs transmit nominally at 401.65 MHz, different frequencies are received by the satellite receivers due to Doppler shift.

1.2. The Space Segment

Argos instruments are flown on board the National Oceanic and Atmospheric Administration (NOAA) Polar Orbiting Environmental Satellites (POES).

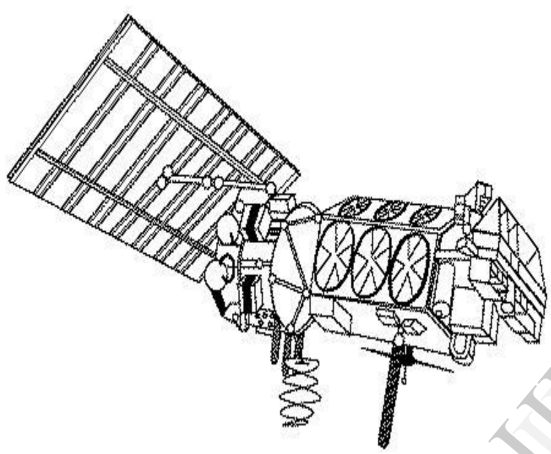

Figure1.4. **TIROS - Polar Orbiting Environmental Satellite**

The satellites receive Argos messages from PTTs and relay them to the ground in real time. They also store them on tape recorders and read out ("dump") the messages to one of three main system ground stations:
- Wallops Island, Virginia, USA,
- Fairbanks, Alaska, USA,
- Lanyon, France.

1.2.1. Polar Orbiting Satellites in Argos Systems:

The Argos Data Collection System (DCS) collects Environmental data radioed up from platform transmitter terminals (PPT).

The PTTs transmit automatically at preset intervals, and those within the 6000 km swath are received by the satellite. Platform Transmitted Terminals(PTT) transfer data from the data logger site to the Argos Data collection and location system via NOAA polar-orbiting satellites. Most of the polar orbiting satellites used in weather and environmental studies, and as used for monitoring and in search and rescue, having a foot print of about 6000 km in diameter. In Actually this is the size of the antenna spot beam on the surface of the beam. The polar orbits allow single satellite to provide coverage of the entire Earth's surface as it rotates through the plane of the orbit over north and south poles. The polar orbits are almost circular, and as that they are at a height of between 800 and 900 km above earth. They carry Ultraviolet sensors that measure Ozone levels, and they can monitor the ozone hole at Antarctica. As mentioned, the satellite completes about 14 orbits daily. At least two satellite are operational at any time, which doubles this number to 28. At equator the position is quite different. The equatorial passes number between six and seven per day for two satellites. During any one pass the PTT is in contact with the satellite for 10 min on average. The Doppler shift in the frequency received at the satellite is used to determine the location of the PTT. The satellite can receive and decode data from several PTTs simultaneously, removing the timing constraints associated with GOES transmissions. In applications point of view where the PPT is mobile (e.g., drifting Oceanographic buoys).

1.2.2 ARGOS - 2 INSTRUMENTS

NOAA-K was successfully launched in May 1998. It will be the first satellite to carry the next generation of Argos instruments (Argos II). This instrument comprises 8 data recovery units (as opposed to 4), operates at a wider bandwidth and carries a more sensitive receiver (Table 3). These capabilities will enable a near quadrupling of capacity for the Argos system. Additional NOAA satellites are planned well into the next century and agreements are being established to carry Argos on other satellites as well. Future considerations are to use the added bandwidth to establish "channels" to meet particular User requirements. For example, a "sensitive" channel for low power transmitters, and a "high data rate" channel for large data volume applications. NASDA, the Japanese Space Agency, will fly the Argos instrument on ADEOS II (launch in 2000). Plans include a downlink to the platforms to enable remote control of PTTs in the field. This "two-way" capability will enable transmitters and sensors to be switched on and off, recalibrated, etc. It markedly increases system functionality and provides Users added flexibility to manage their programs. Indeed, "Downlink Messaging" represents yet another era in the evolution of the Argos system.

1.3. The Ground Segment

Figure 1.5 shows the Argos System Configuration for receiving and processing facilities. Upgrades to computer equipment and communications links are made throughout the segment. Argos Global Processing Centers (GPC) are fully redundant.

1.3.1 Receiving Stations

The three main ground stations (Wallops Island, Fairbanks, and Lanyon) receive all messages recorded by the satellite during an orbital revolution, providing complete global coverage. Regional receiving stations receive transmitter data from the satellites in real time whenever a satellite is within station visibility. The main ground stations also act as regional receiving stations which operate in Largo, Hawaii and Monterey in the USA; Halifax and Edmonton in Canada; Toulouse, France; Casey, Antarctica;

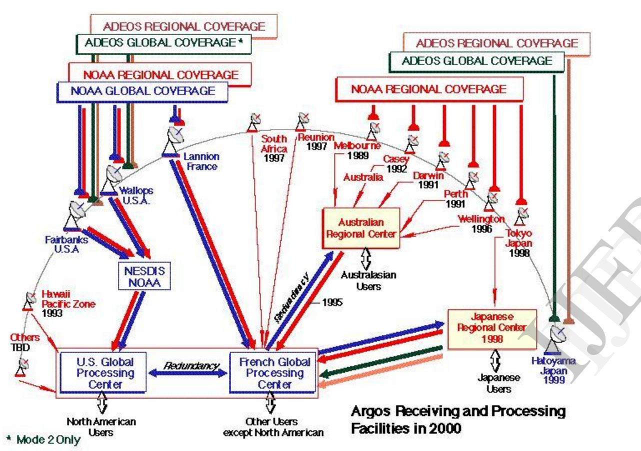

Figure 1.5. **Argos System Configuration for Receiving and processing facilities**

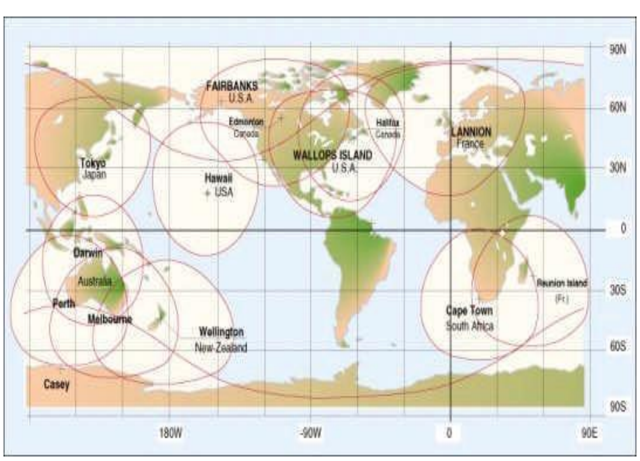

Figure1.6. Regional (near-real time) Coverage

Cape Town, South Africa; Tokyo, Japan; Darwin, Melbourne and Perth in Australia; Wellington, New Zealand; Reunion Island (FR) (Figure1.6.).

1.3.2 Processing

The work of a GPC includes:

• Quality control, including checking of message time-tagging, signal level, transmitter ID number ,length of sensor data message, and the receive frequency for use in the Doppler location calculation.
• Message classification in chronological order.
• Location calculation
• Sensor data processing
• Data distribution via network or physical media
• Archival of processed data.

The data from each sensor on a given transmitter is processed separately. Users can therefore choose different processing options:

• A - which outputs the raw sensor data as numerical values,

• B - which converts raw sensor data into physical values using a different calibration curve for each sensor.

2.ARGO FLOATS

Argo is an international collaboration that collects high-quality temperature and salinity profiles from the upper 2000m of the ice-free global ocean and currents from intermediate depths. The data come from battery powered autonomous **floats** that spend most of their life drifting at depth where they are stabilised by being neutrally buoyant at the "parking depth" pressure by having a density equal to the ambient pressure and a compressibility that is less than that of sea water. At present there are three models of profiling float used extensively in Argo. All work in a similar fashion but differ somewhat in their design characteristics. At typically 10-day intervals, the floats pump fluid into an external bladder and rise to the surface over about 6 hours while measuring temperature and salinity. Satellites determine the position of the floats when they surface, and receive the data transmitted by the floats. The bladder then deflates and the float returns to its original density and sinks to drift until the cycle is repeated. Floats are designed to make about 150 such cycles. Argo is a global array of 3,000 free-drifting profiling floats that measures the temperature and salinity of the upper 2000 m of the ocean. This allows, for the first time, continuous monitoring of the temperature, salinity, and velocity of the upper ocean, with all data being relayed and made publicly available within hours after collection.

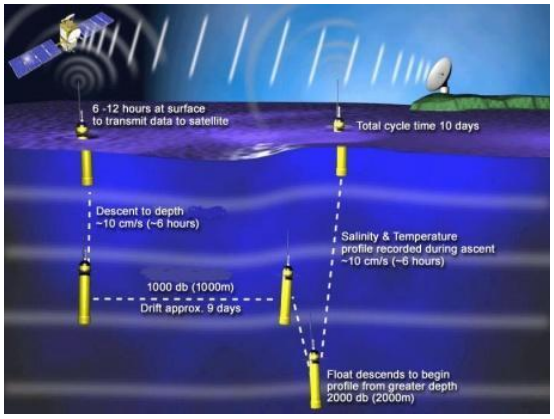

Figure 2.1

2.1 Need of Argo

We are increasingly concerned about global change and its regional impacts. Sea level is rising at an accelerating rate of 3 mm/year, Arctic sea ice cover is shrinking and high latitude areas are warming rapidly. Extreme weather events cause loss of life and enormous burdens on the insurance industry. Globally, 8 of the 10 warmest years since 1860, when instrumental records began, were in the past decade.

These effects are caused by a mixture of long-term climate change and natural variability. Their impacts are in some cases beneficial (lengthened growing seasons, opening of Arctic shipping routes) and in others adverse (increased coastal flooding, severe droughts, more extreme and frequent heat waves and weather events such as severe tropical cyclones).

Understanding (and eventually predicting) changes in both the atmosphere and ocean are needed to guide international actions, to optimize governments' policies and to shape industrial strategies. To make those predictions we need improved models of climate and of the entire earth system (including socio-economic factors).

Lack of sustained observations of the atmosphere, oceans and land have hindered the development and validation of climate models. An example comes from a recent analysis which concluded that the currents transporting heat northwards in the Atlantic and influencing western European climate had weakened by 30% in the past decade. This result had to be based on just ***five*** research measurements spread over ***40*** years. In 1999, to combat this lack of data, an innovative step was taken by scientists to greatly improve the collection of observations inside the ocean through increased sampling of old and new quantities and increased coverage in terms of time and area.That step was Argo.

Figure 2.2

2.2 Argo Design and Data

The design of the Argo network is based on experience from the present observing system, on recent knowledge of variability from the TOPEX/Poseidon altimeter, and on the requirements for climate and high-resolution ocean models.

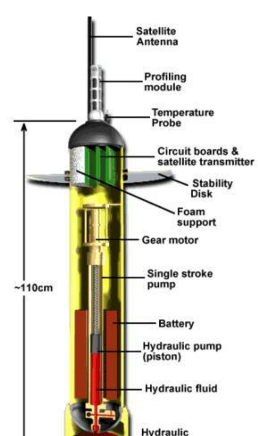

Figure 2.3 Float design

The final array of 3000 floats will provide 100,000 Temperature/Salinity (T/S) profiles and velocity measurements per year distributed over the global oceans at average 3-degree spacing. Floats will cycle to 2000m depth every 10 days, with 4-5 year lifetimes for individual instruments. All data collected by Argo floats are publically available in near real-time via the Global Data Assembly Centres (GDACs) in **Brest, France** and **Monterey, California** after an automated quality control (QC), and in scientifically quality controlled form, delayed mode data, via the GDACs within six months of collection.

2.3 Argo's Objectives

Argo will provide a quantitative description of the changing state of the upper ocean and the patterns of ocean climate variability from months to decades, including heat and freshwater storage and transport. The data will enhance the value of the Jason altimeter through measurement of subsurface temperature, salinity, and velocity, with sufficient coverage and resolution to permit interpretation of altimetry sea surface height variability.

Argo data will be used for initializing ocean and coupled ocean-atmosphere forecast models, for data assimilation and for model testing.A primary focus of Argo is to document seasonal to decadal climate variability and to aid our understanding of its predictability. A wide range of applications for high-quality global ocean analyses is anticipated.

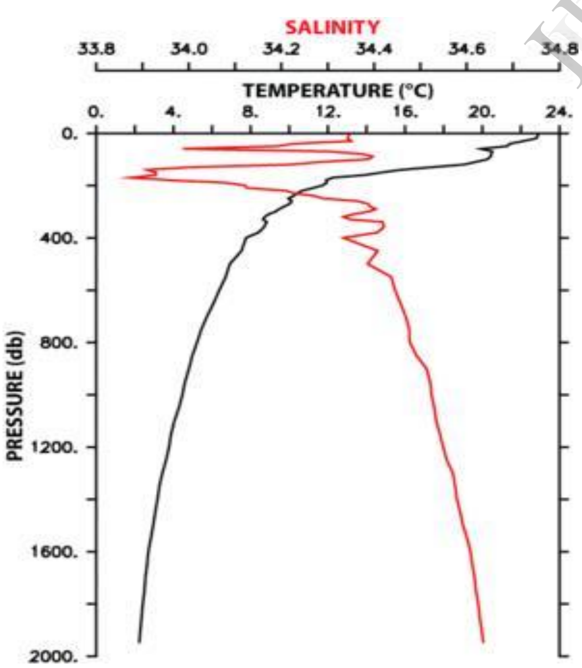

Figure 2.4 An Argo profile from the subtropical North Pacific (20.25N 121.4W, May 15 2004). This shows interleaving in the salinity data.

2.4 Argo Float Models

Most of the Argo array is currently comprised of three float models the **PROVOR** built in France in close collaboration withIFREMER, the **APEX** float produced by Teledyne Webb Research and the **SOLO** float designed and built by Scripps Institution of Oceanography, USA.

The **ARVOR** is a new generation PROVOR float and it is also being built by NKE-INSTRUMENTATION. The SOLO-II is a new generation SOLO and is being built by **MRV systems**. Two temperature/salinity sensor suites are used - **SBE**, and **FSI**. The temperature data are accurate to a few milli degrees over the float lifetime. For discussion of salinity data accuracy please see the section on the Argo data system.

2.5 Argo Data Transmission

As the float ascends a series of typically about 200 pressure, temperature, salinity measurements are made and stored on board the float. These are transmitted to satellites when the float reaches the surface. For most floats in the Argo array the data are transmitted from the ocean surface via the System location and data transmission system. The data transmission rates are such that to guarantee error free data reception and location in all weather conditions the float must spend between 6 and 12 hrs at the surface. Positions are accurate to ~100m depending on the number of satellites within range and the geometry of their distribution. An alternative system to Argos has been tested using positions from the Global Positioning System (GPS) and data communication using the **Iridium** satellites.Iridium is becoming a more attractive option as it allows more detailed profiles to be transmitted with a shorter period at the surface and even two-way communication.

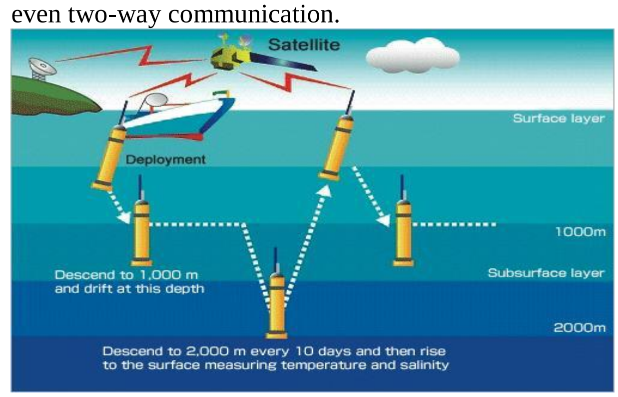

Figure 2.5. Argo Data Transmission

3. THE ARGO DATA SYSTEM

When a float surfaces, the data are transmitted and the float's position determined (mostly through system Argos). The data are monitored by the **Argo Information Centre** in Toulouse and then received by national data centres (DACs). At the DACs, they are subjected to initial scrutiny where erroneous data are flagged and/or corrected and the data are passed to Argo's two Global Data Assembly Centres (GDACS) in **Brest, France** and **Monterey, California**. The GDACs are the first stage at which the freely available data can be obtained via the internet. The GDACs synchronize their data holdings to ensure consistent data is available on both sites. The data reach operational ocean and climate forecast/analysis centers via the **Global Telecommunications System (GTS)**.

The target is for these "real-time" data to be available within approximately 24 hours of their transmission from the float.

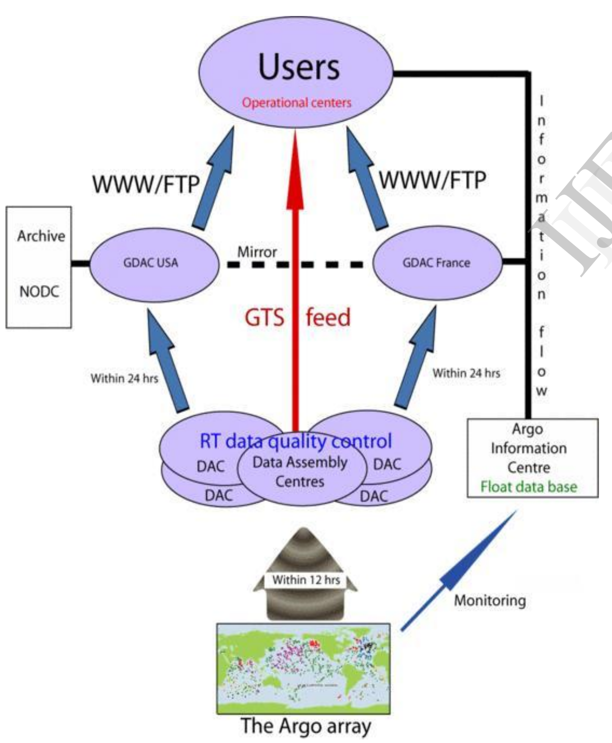

Figure3.1 Real time data flow

In addition to the real-time data stream, Argo has the potential, after careful data assessment, to provide salinity/temperature/pressure profiles that approach ship-based data accuracy.

The delayed-mode quality control is the responsibility of researchers in each country in collaboration with the appropriate national data centre.

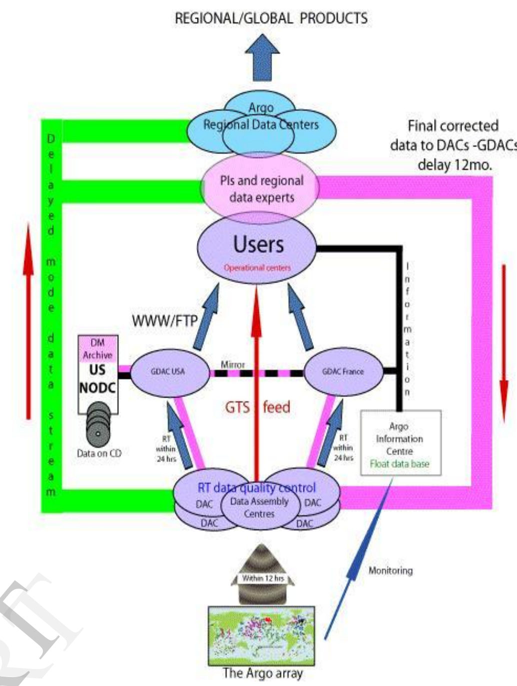

Figure3.2 Real time and delayed mode data flow.

It has been recommended that delayed mode data inspection is carried out on a 1 year long record so that sudden jumps in calibration may be distinguished from long term drift or water mass property changes. This imposes a minimum 6 month delay on the availability of delayed mode data. This system was adopted in 2004 and is now being applied to Argo data. These delayed-mode data are currently available from the GDACs. To learn more about the data management of Argo and how to use the Argo data effectively, visit the **Carioles Site**. An additional phase of Argo data management occurs at a regional level at the Argo Regional Centres (ARCs). This enables the accumulation of consistent regional data sets and the production of Argo based products. To learn more about the Argo Regional Centres, go to **ARC page**. The **Argo Information Centre** is a source of information about the development and performance of the global array and the national programmes that contribute to it. The final repository for Argo data is with the **US National Oceanographic Data Centre (NODC)**. They will also distribute Argo data on CDs so as to permit Argo data use by groups without reliable or low cost internet access.

4. SATELLITE TRANSMISSION FOR ARGO FLOATS

Most of the floats use the Argos System of satellites to recover data. Argos is a satellite-based system which collects, processes and disseminates environmental data from fixed and mobile platforms worldwide. What makes Argos unique is the ability to geographically locate the source of the data anywhere on the Earth utilizing the Doppler effect.

Argos was established in 1978 and since that time, it has provided data to environmental research and protection communities that, in many cases, was otherwise unobtainable. Argos is a key component of many global research programs including: TOGA, TOPP, WOCE, **ARGO** and others.

The Argos System is the only global positioning system and data collection satellite dedicated to studying and protecting the global environment.

The one-way communication : Argos-2

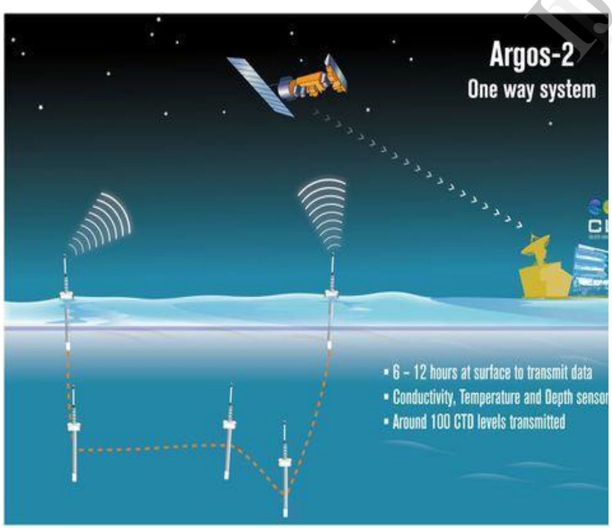

Figure 4.1 The one way communication

The first Argos-2 system was a one way of communication with the platforms, which needed Argo floats to spend 6 to 12 hours at surface to transmit around 100 levels of only CTD sensors**.**

The two-way communication system : Argos-3 and Iridium

For Argo deployments, the performances of these instruments could be affected in marginal seas. Thus,it is critical to reduce the transmission time at surface,in order to lower the risk of thefts, trawling or impacts in these highly trafficked seas ,to delay the time of beaching on the shores ,to have better estimates of subsurface currents.

The new Argos-3 and Iridium satellite transmissions respond to this necessity of a two-way communication will be the platform.

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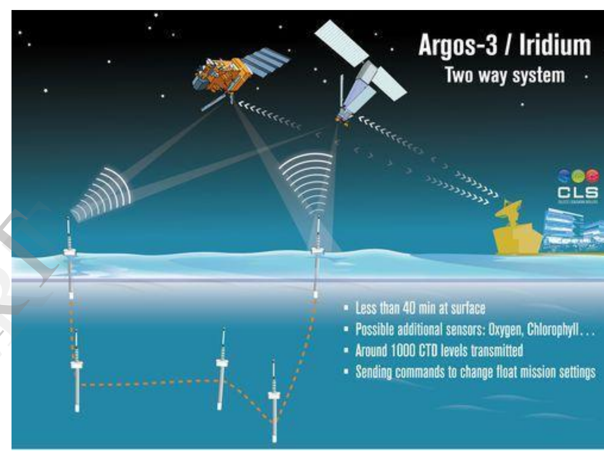

Figure 4.2 The two way communication

So the Argos-3 System send more data, Reduce surface time of the float (less than 40 min at surface) , improve transmission efficiency .

A few of Argo floats are using the newer Iridium satellite constellation. The Iridium satellite constellation is a large group of satellites providing voice and data coverage to satellite phones, pagers and integrated transceivers over Earth's entire surface.

The Iridium system offers significant advantages associated with the much faster data transfer. Since an Iridium float spends only 3 minutes at the sea surface, the opportunity to observe surface currents by tracking the movements of the floats is lost but the trajectories of the floats become more representative of the flow at their parking depth.

5. APPLICATIONS

Oceanography:
The key international oceanography programs use Argos to transmit data via satellite from ocean buoys to information networks shared by professionals around the world.

Argo: Global ocean observing program
The Argo program comprises a network of oceanography floats belonging to 25 countries. The program's ultimate objective is to release 3000 floats covering ice-free areas to study long-term ocean variability. Data collected from these floats, including temperature and salinity profiles, are relayed by Argos. They are then distributed worldwide and posted on websites as well as specialized information networks. These data are giving scientists valuable information about the oceans and their role in shaping climate - a key element of the Global Ocean Observing System (GOOS) seeking to ensure sustainable development of our planet.

Global Drifter Program
The goal of the Global Drifter Program is to produce new charts of seasonal surface circulation of the world ocean. The data collected via Argos, provides key information for scientists to study SST, Sea level pressure, and surface velocity of the ocean ;Verify global climate models ,Eddy statistics and variables throughout the year ,Construct models of wind driven currents.

6. CONCLUSION

In this paper, introduced about Argos and the subsystems involved in it and the transmission pattern between Argo floats and satellites and along their communication. Nowadays, 4 Argos-2 and 4 Argos-3 satellites are operational. An additional Argos-3 satellite will be deployed in 2014. An innovative Argos-4 system is in development.

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