

# **Present Status of Ocean Observation**

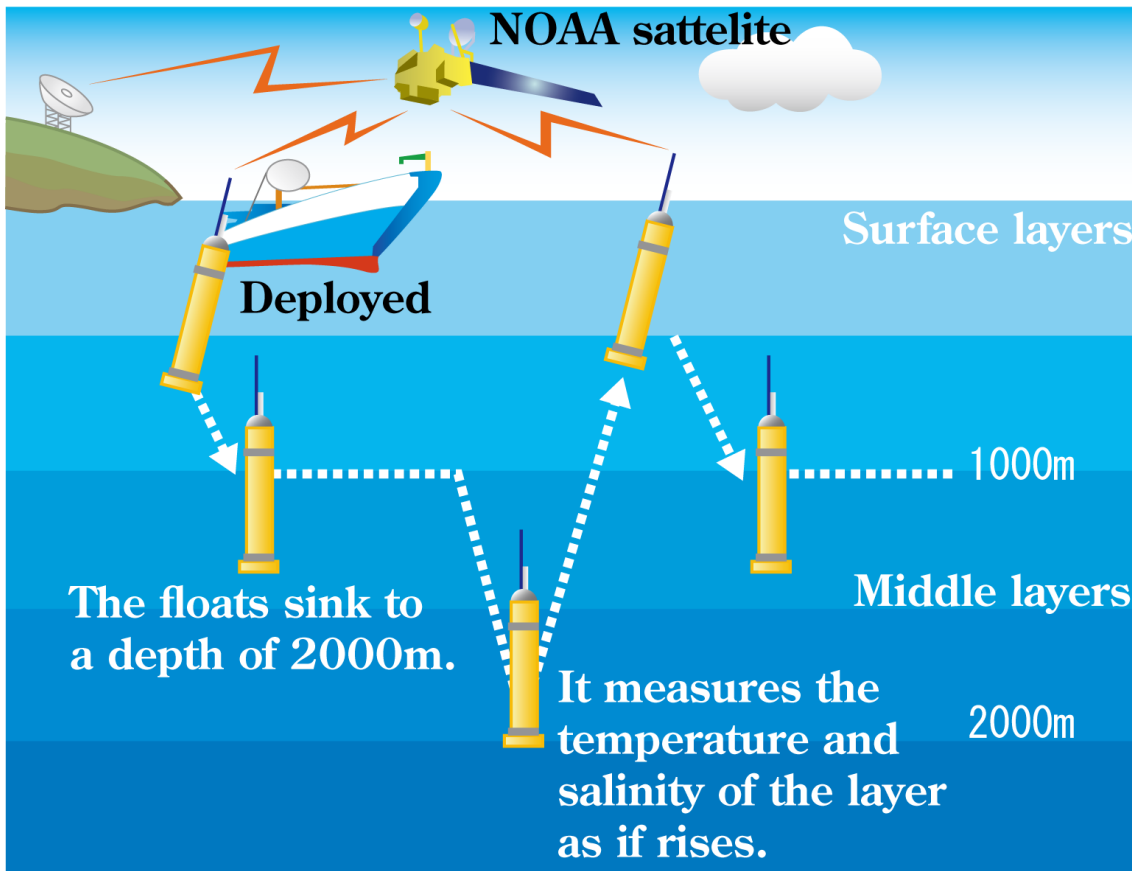
## **- GCOS oriented projects in blue water -**

### **Overview of Argo and Repeat Hydrography**

*Takeshi KAWANO*  
*JAMSTEC*

# What is Argo Float?

**The centerpiece of the in-situ ocean observing system in GEO&GEOSS**

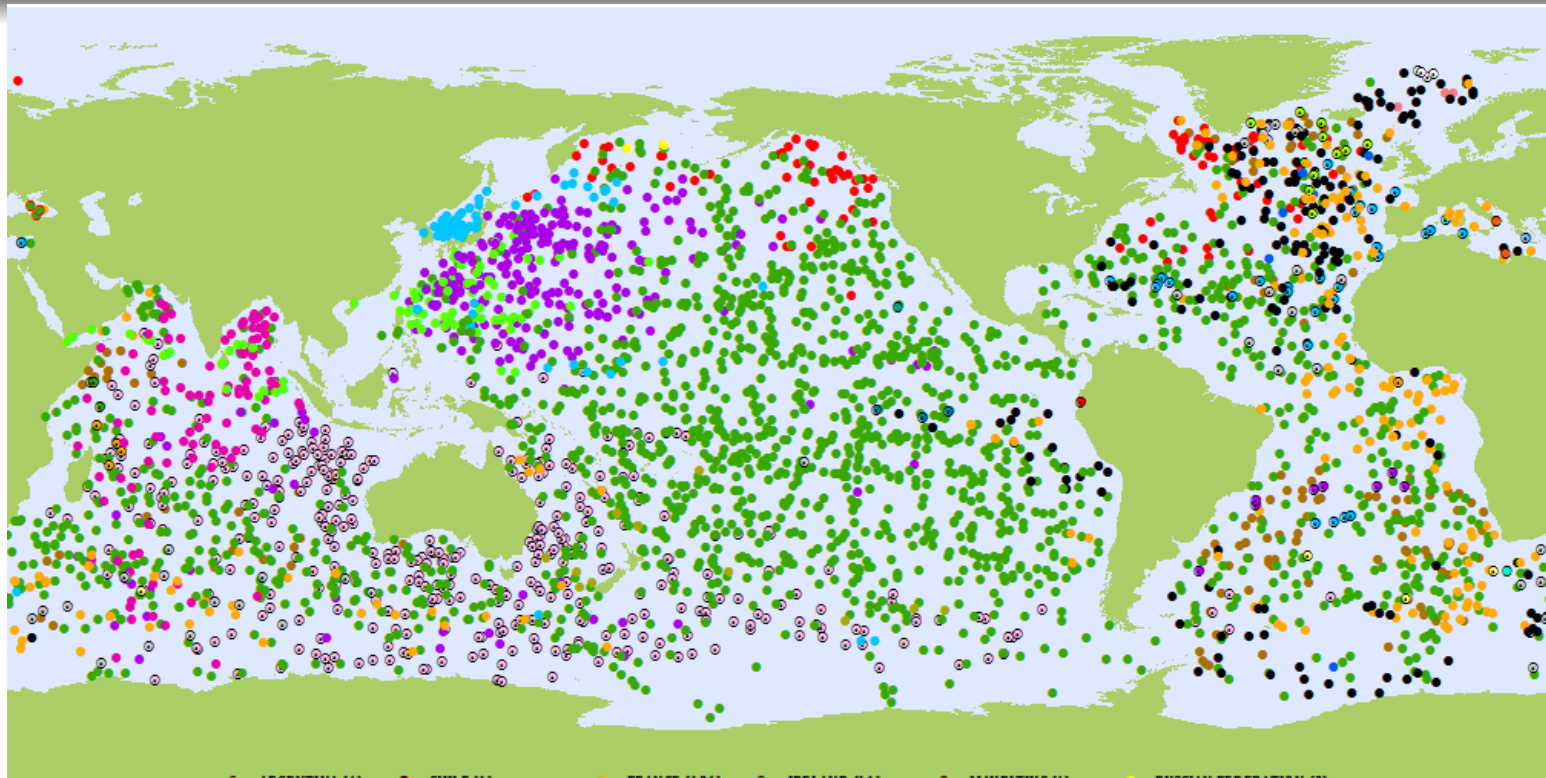


Argo float is battery-powered autonomous floats which can observe vertical profile of temperature and salinity in real-time.

The operation:

The float descends to a certain (programmed) depth, typically 1000m, and then descends to 2000m to start the measurement of temperature and salinity profile. When it comes to the surface, data is transmitted by satellite.

# Active Floats Map



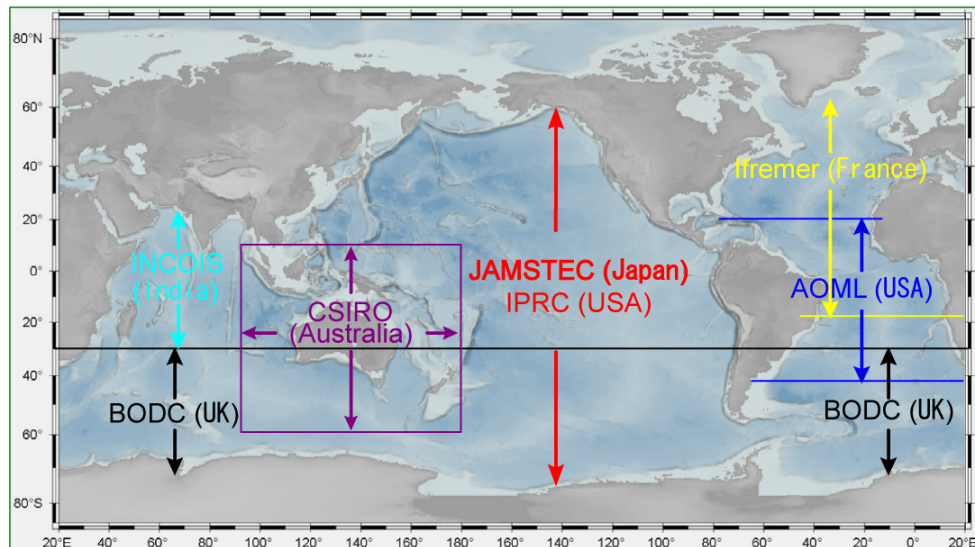
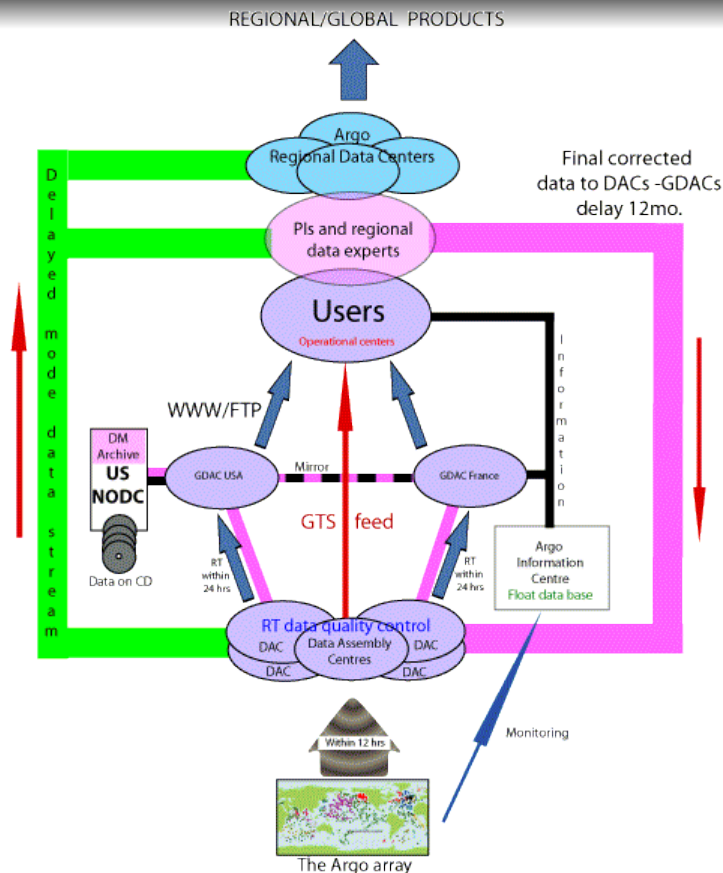
**3500 Active Floats**

○ ARGENTINA (4)	● CHILE (1)	● FRANCE (196)	○ IRELAND (11)	○ MAURITIUS (4)	○ RUSSIAN FEDERATION (2)
○ AUSTRALIA (385)	● CHINA (85)	● GABON (1)	● ITALY (2)	● MEXICO (1)	● SOUTH AFRICA (1)
● BRAZIL (8)	● ECUADOR (3)	● GERMANY (176)	● JAPAN (269)	○ NETHERLANDS (37)	● SPAIN (32)
● BULGARIA (3)	● EUROPEAN UNION (6)	● GREECE (1)	● KENYA (3)	● NEW ZEALAND (11)	● UNITED KINGDOM (126)
● CANADA (98)	○ FINLAND (4)	● INDIA (100)	● SOUTH KOREA (79)	● NORWAY (3)	● UNITED STATES (1848)

February 2012

Core mission of the international Argo project is to deploy floats in the world ocean to obtain temperature and salinity profile from roughly every 3 degrees every 10 days. Required number of floats is 3,000 between 60°S and 60°N. This was accomplished in 2007 by the international collaboration. Today, 3,500 floats are operated in the world Oceans.

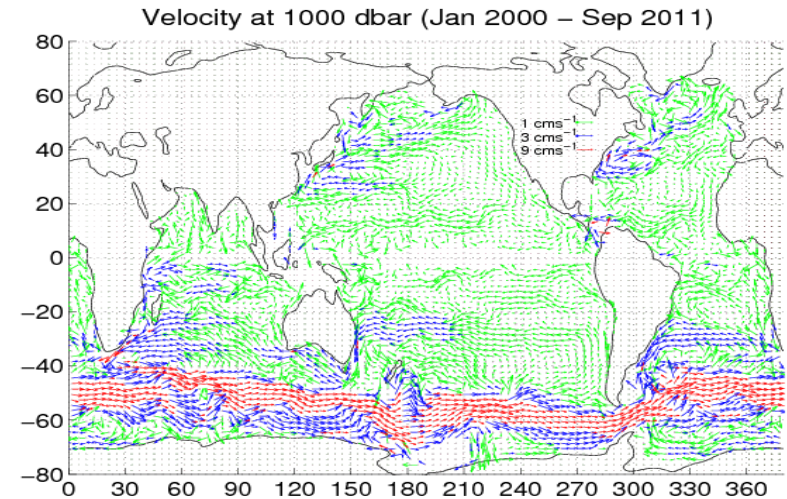
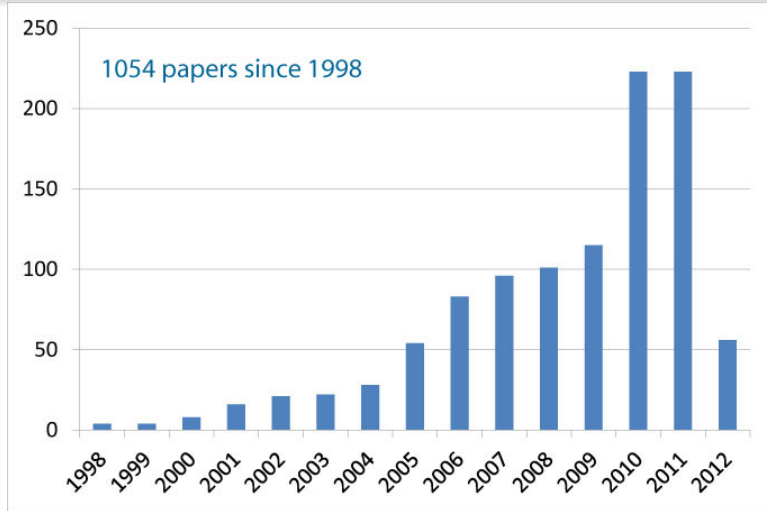
# Two Kinds of Data Flow



All data are relayed and made publicly available within hours after collection. The initial QC'ed data are passed to Argo's two Global Data Assembly Centers (GDACS) in Brest, France and ~~Monterey, California~~.

In the Pacific, JAMSTEC runs the Pacific Argo Regional Center (PARC) in cooperation with CSIRO/Australia and IPRC/US. PARC is responsible for supervising the quality control level of Argo data observed in the Pacific. PARC is also creating useful products and exhibiting them on its website as providing high quality data to users.

# Contribution to Society



Argo project is well designed and works well.

- Contribution to scientist. → more than 1000 papers.
- Valuable products are published such as horizontal distribution of velocity.
- Data from Argo Array is crucial to assimilation.
- GTS data has been used by operational agencies such as meteorological agencies, fishery agencies and so on.



# Challenge

## Western North Pacific Integrated Physical-Biogeochemical Observation Experiment (INBOX)

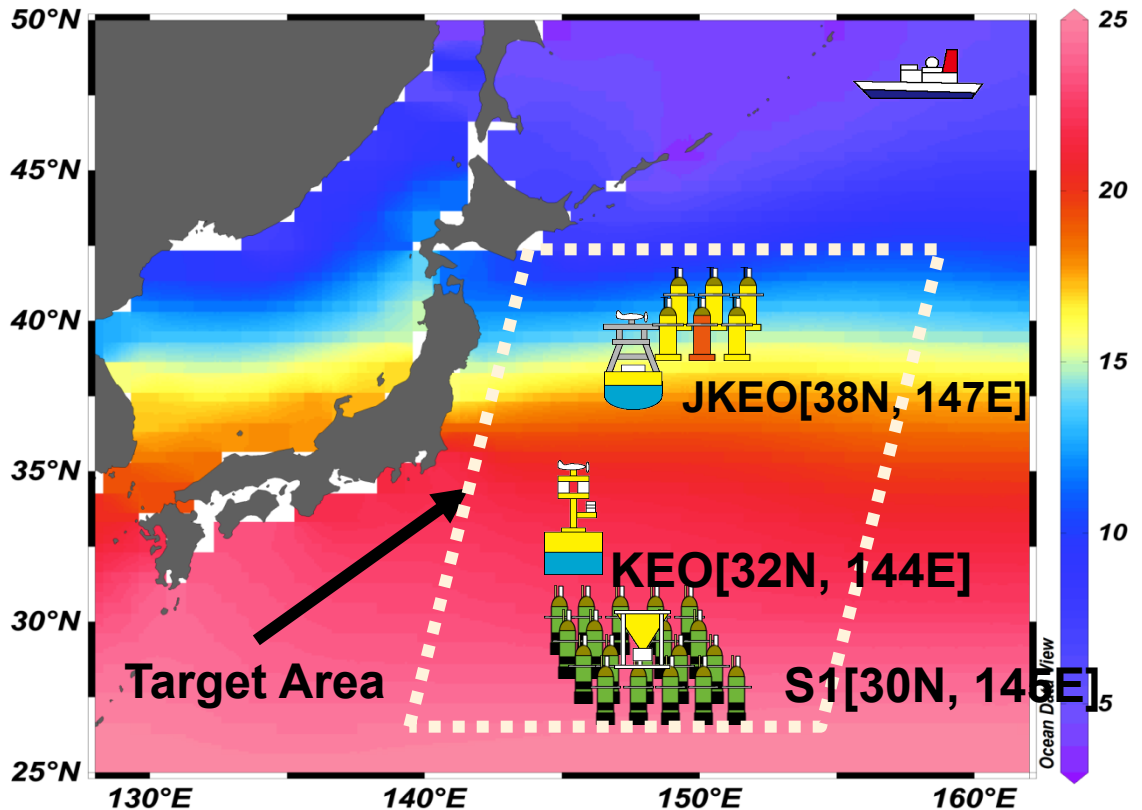
### Bio-Argo deployment

25 Apex floats with DO sensor in 150x150 km

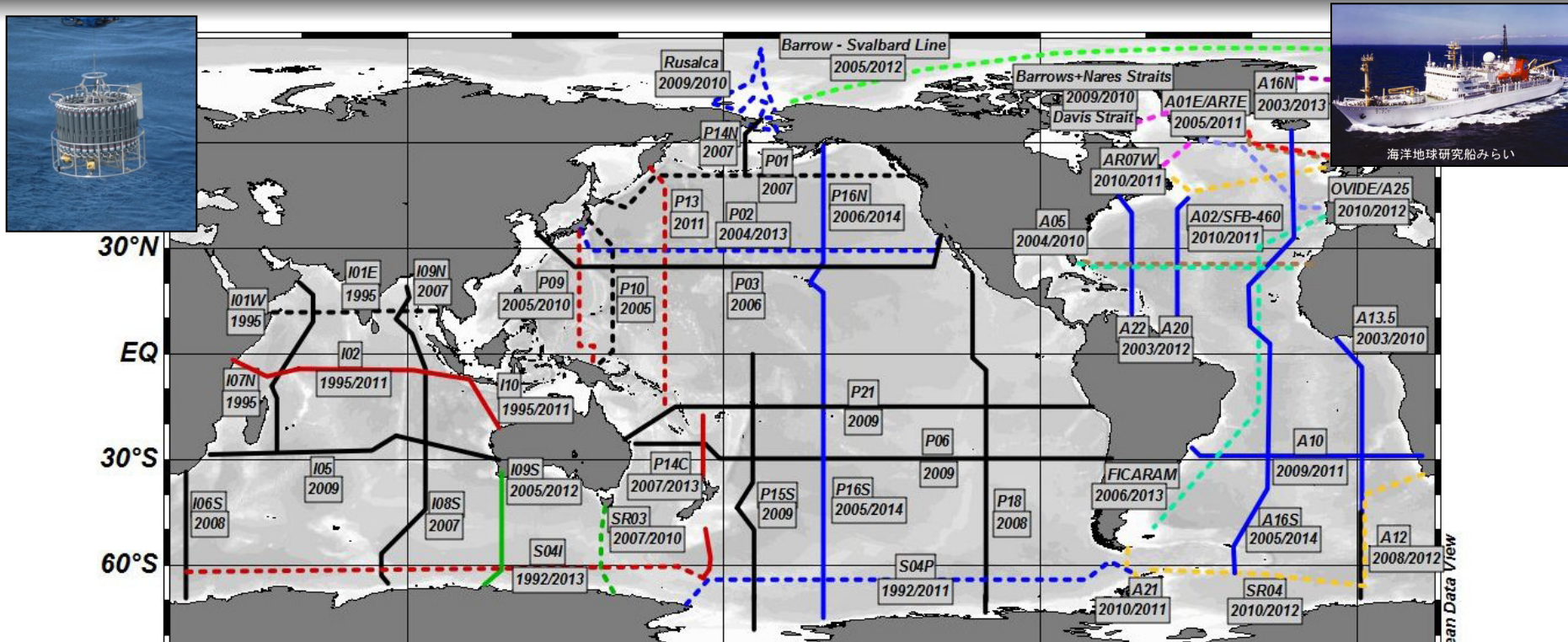
Sediment trap mooring at 30N 145E with ADCP at 200m and CTD on the sediment trap observes 0-200m once per day



### Temperature [degC] Sea Surface



# Repeat Hydrography



Ship-based hydrography remains the only method for obtaining high-quality, high spatial and vertical resolution measurements of a suite of physical, chemical, and biological parameters over the full water column. The task of the Repeat Hydrography Programme is to observe the ocean with high-quality measurements from the surface to the bottom along historical (WOCE) hydrographic lines. To cover the global ocean, the program GO-SHIP is conducted with the framework of Climate Variability and Predictability (CLIVAR) and International Ocean Carbon Coordination Project (IOCCP).

# Data distribution

Environmental Sciences Division • Oak Ridge National Laboratory • U.S. Department of Energy

## Carbon Dioxide Information Analysis Center – Ocean CO<sub>2</sub>

*All CDIA Ocean Carbon Data*

*General Information*

*WOCE Project Carbon Data*

*Ocean Carbon and Repeat Hydrography CLIVAR Program Data*

*VOS Project Carbon Data*

*Timeseries and Moorings Data*

*Global Coastal Program Data*

*CARINA Database*

*PACIFICA Database*

*SOCAT Database*

*LDEO Database*

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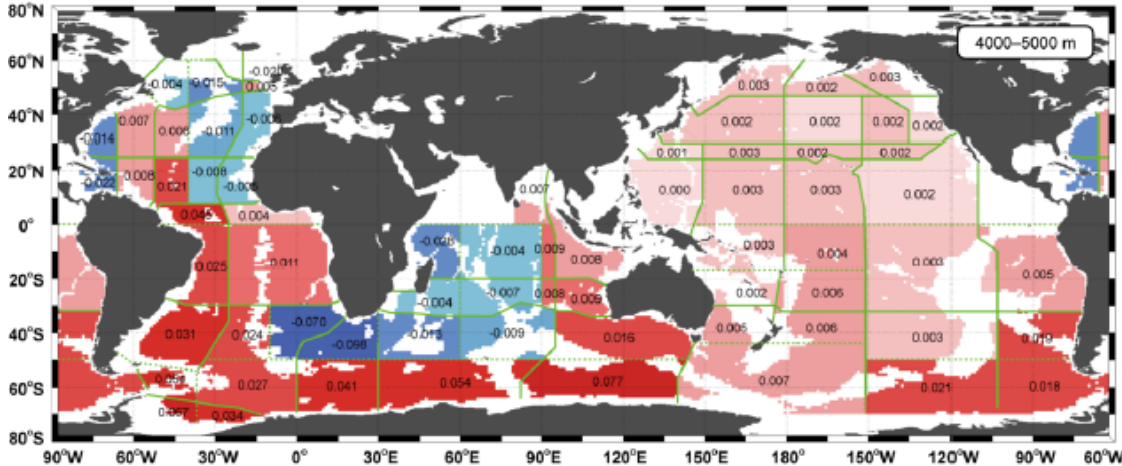
## GLobal Ocean Data Analysis Project

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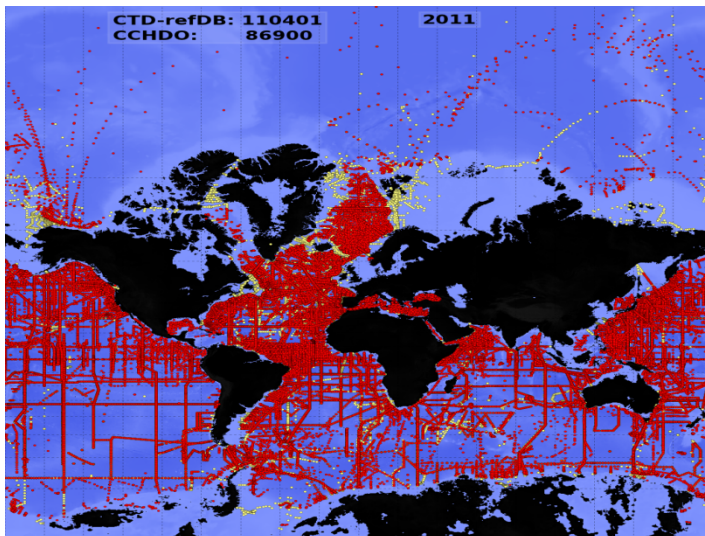
# Contribution

(b) 4000–5000 m



## Deep Water Warming

Deep water has been warmed by ca. 0.003 – 0.01 /decade in the Oceans. This suggests the change in the deep water formation rate in the southern Oceans, which could affect the long-term climate change.



## Argo Reference Database

The free-moving nature of profiling floats means that most float measurements are without accompanying in-situ “ground truth” values for absolute calibration (such as those afforded by shipboard CTD measurements). Therefore Argo delayed-mode procedures for checking sensor drifts and offsets in salinity rely on reference datasets and statistical methods. .

# Data Synthesis in the Pacific

## PACIFICA is ...

An international collaborative activity under the umbrella of  
(North Pacific Marine Science Organization)



- to create a **synthesized data base (PACIFICA)** of **water-column CO<sub>2</sub>** related parameters such as DIC, TA, pH(total), oxygen, nutrients, CFCs and salinity,
- for the **North** and the **South Pacific**, and their **marginal seas**,
- that has gone through a **2<sup>nd</sup>-level quality control**.

[1] **Crossover analysis** parameter by parameter

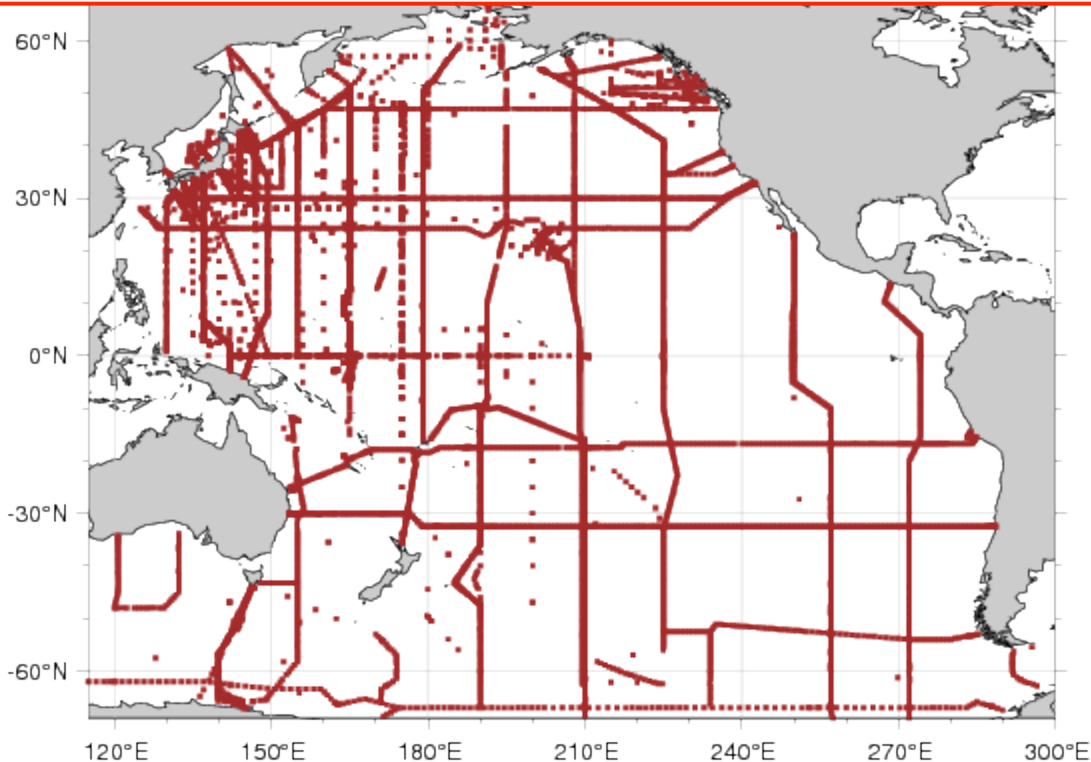
[2] Evaluation of **systematic offset** by **inversion**

[3] **Assignment** of the offset by WG by considering **not to erase real temporal change** from oceanographic points of view

[4] **Adjustment** of offsets

## Data collection – total of 247 cruises

$\beta$ -version has been published !



### Repeat hydrography:

P15S (2001) CSIRO  
 P17N (2001) JAMSTEC  
 P06 (2003) JAMSTEC  
 P02 (2004) PMEL  
 P10 (2005) JAMSTEC  
 P16S (2005) PMEL, SIO  
 P03 (2005) JAMSTEC  
 P16N (2006) PMEL, AOML  
 P01 (2007) JAMSTEC  
 P14 (2007) JAMSTEC  
 .....

- Datasets of post-WOCE cruises that include high-quality carbon system data (DIC, TA, pH) with hydrographic/chemical data including DO and nutrients. Many of these datasets also include data of transient tracers such as  $^{14}\text{C}$ ,  $^{13}\text{C}$  and CFCs.
- Datasets that include carbon system measurements that are not in GLODAP.

# Status against the GCOS Implementation Plan and JCOMM targets

continuous satellite measurements of sea surface temperature, height, winds, and colour



Total *in situ* networks

**62%**

December 2011



100% **Surface measurements** from volunteer ships (VOSclim)  
200 ships in pilot project



100% **Global drifting surface buoy array**

- Completion rate has remained around 60% for these 3 years.
- Continuation of organizing structure such as secretariat, steering committee, etc., becomes endangered due to financial problem of IOC (especially, GO-SHIP).



80% **XBT sub-surface temperature section network**  
51 lines occupied



100% **Profiling float network (Argo)**  
3° resolution array: 3000 floats

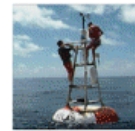


62% **Repeat hydrography and carbon inventory**  
Full ocean survey in 10 years

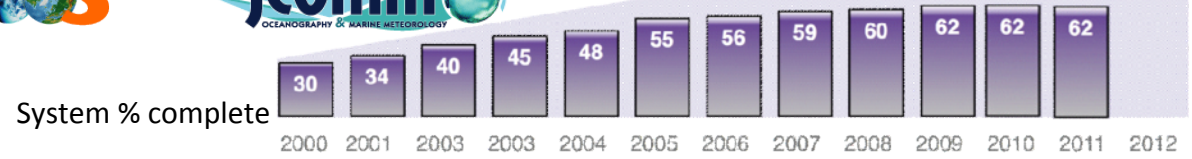
**Reference time series** 48%  
58 sites



34% **Global reference mooring network**  
29 moorings planned



73% **Global tropical moored buoy network**  
119 moorings planned



Original goal: 100% implementation in 2010



# Summary

Global Ocean Observations by Argo and Repeat Hydrography work well so far.

- Networks are well designed through the international agreement.
- Data has been opened soon enough or at the appropriate time and various kinds of data and products are well distributed.
- Outcomes from observations have been contributed to the society.
- Expansion of Argo is planned.

Maintenance of networks is highly required.