Stratégie internationale, européenne et plans français sur Deep Argo

NAOS #4
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Deep Argo Implementation Workshop

May 5-7th, 2015 in Hobart, Tasmania

Organisation: Nathalie Zilberman, Guillaume Maze
Steering committee: Dean Roemmich, Susan Wijffels, Steve Riser, Toshio Suga, Katsuro Katsumata, Breck Owens, Greg Johnson, Brian King, and Bernadette Sloyan

Report: http://www.argo.ucsd.edu/DAIW1report.pdf

30 participants
6 Countries (U.S, France,
U.K, Australia, New Zealand, Japan)

- Objectives of the Deep Argo program
- Anticipated configuration of the Deep Argo array
- Deep Argo float characteristics and CTD sensor development
- Deep Argo pilot arrays
- Summary

Objectives of the Deep Argo program

1. Operational application

Improve global ocean reanalysis and coupled ocean-atmosphere forecasting systems below 2000 m (assimilation, constraint, OSSEs, removal of deep bias). A warning was raise with regard to the upgrade vs added fleet of deep floats (profile's age...)

2. Research

Significant progress in global heat budget and freshwater storage

Improve knowledge of regional distribution of regional sea level budget, and quantification of the causes of sea level change

Provide basin coverage of deep ocean circulation

The ability to track the planetary energy budget in real time !

Many other research topics (mixing, ice melting, TS structure, ...)

3. Mutidecadal climate change assessment

IPCC AR5, BAMS state of the climate reports, ...

Expected major progress

"Deep Argo has the potential to achieve the GOSHIP survey every year for T and S"

- **Change detection** – building a well sampled unbiased and detailed modern ocean climatology – against which older data can be compared for past change detection

- Detailed **stratification and shear** climatology – we will learn a great deal about the deep circulation, its relationship to topography and source regions.

- Deep Argo will have relevance to several CLIVAR (Climate Variability and Predictability) research panels and the WCRP (World Climate Research Programme) Grand Challenges on **sea level, and on the planetary radiation budget.**

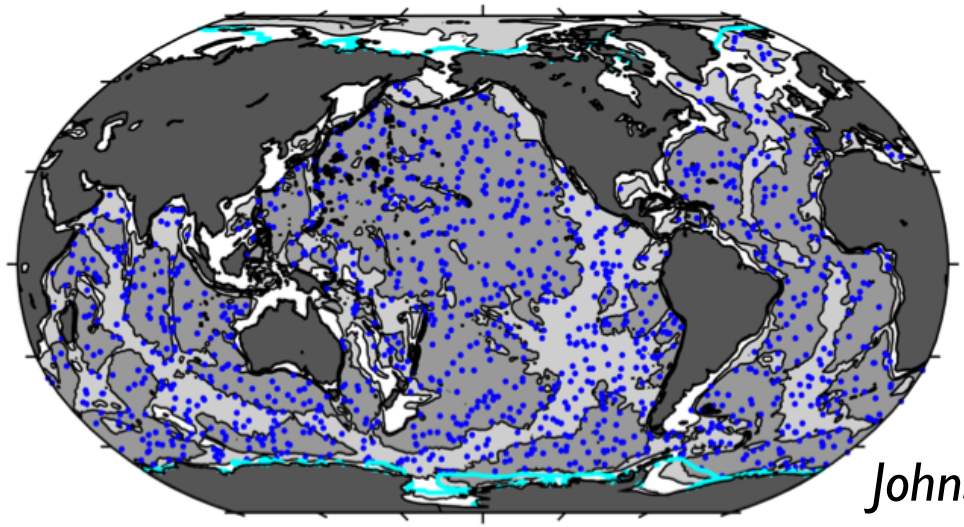
- **Decadal variability** – this is very important for sea level variability and regional climate projections. Deep Argo will be important for initializing these systems and helping to underpin the theory and basis of decadal predictability.

- **Mixing** – what can we measure and learn? If full resolution 2 dbar profiles are achievable, what could this do to advance our understanding of mixing processes and their spatial/temporal distribution?

- **Oxygen** – some deep floats can carry these sensors. It has a large dynamic range and thus the signal to noise might be larger compared to T and S. What science questions could be addressed with Deep oxygen? Are the sensors adequate for this? Is oxygen a possible future extension?

Deep Argo program
Workshop straw plan

Only one plan discussed during the workshop



Johnson et al, 2015

- Sample to the ocean bottom
- 1 float 5x5 spacing: ~1200 floats
- 1 profile/month

The meeting agreed such a plan was achievable and met nearly all science goals

This plan affordability was questionned but the need for a global array was agreed, with a pathway to it via some regional pilots and other sparse deployments. Ongoing sensor development is needed.

Deep Argo floats

Deep NINJA

TSK Co LTD, JAMSTEC
0 – 4000 m
SBE-41 CTD
50 kg
15 deployed so far

Deep APEX

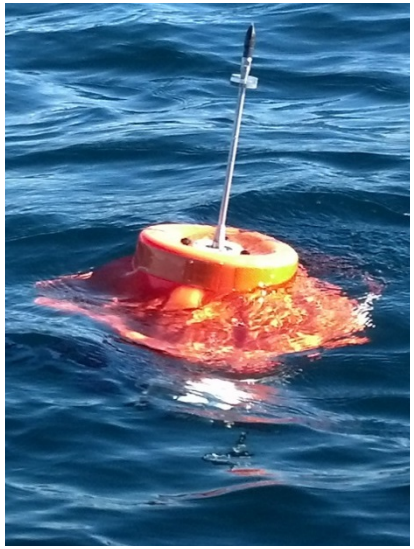
TWR, UW
0 – 6000 m
SBE-61 CTD
43 cm glass sphere
2 deployed

Deep ARVOR

Ifremer, NKE, CNRS
0 – 4000 m
SBE-41 CTD
26 kg
8 deployed

Deep SOLO

SIO
0 – 6000 m
SBE-61 CTD
25 kg
33 cm glass sphere
3 deployed



CTD sensors: SBE-61

Sea-Bird: "WOCE for life"

almost done...

Collaboration of N.Z/U.S./Aus. Argo and Sea Bird Electronics

9-day cruise on R/V Tangaroa - June 16-25th 2014

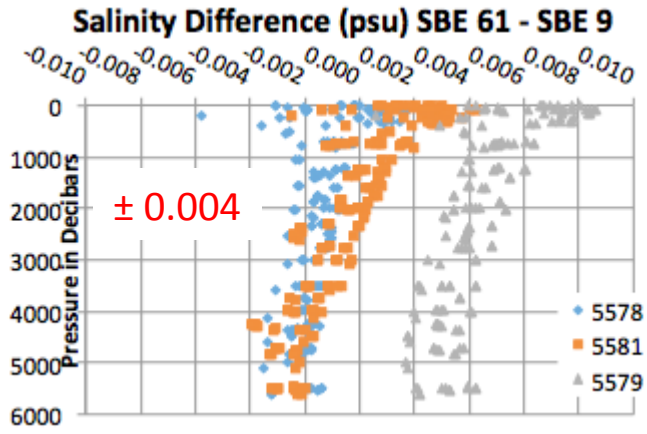
12 Repeat CTD casts to 5600m with water samples

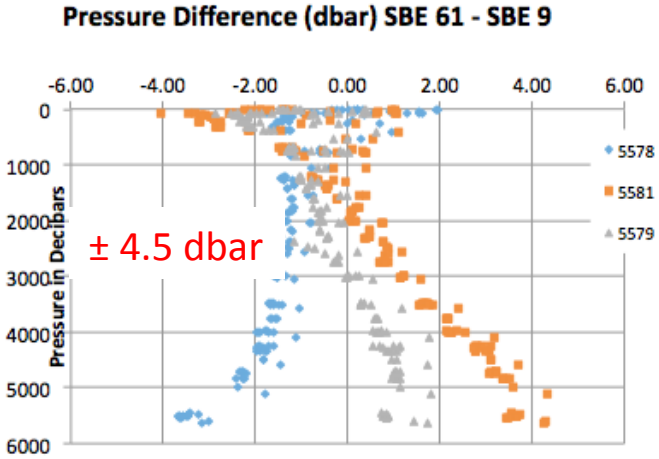
3 SBE-61 CTDs were integrated in the shipboard system to compare SBE-61 CTD (P,T,S) with shipboard CTD.

Temperature is meeting the ±0.001°C accuracy goal

Salinity is approaching the desired accuracy of ±0.002. Refinements in pressure and conductivity may yield improvement.

Pressure is approaching the desired accuracy of ±3 dbar. Further work needed via mechanical design work and calibration process.

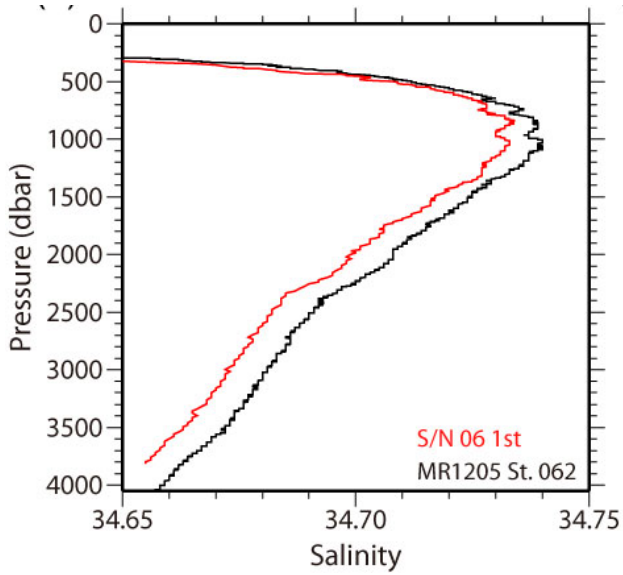




CTD sensors: SBE-41CP

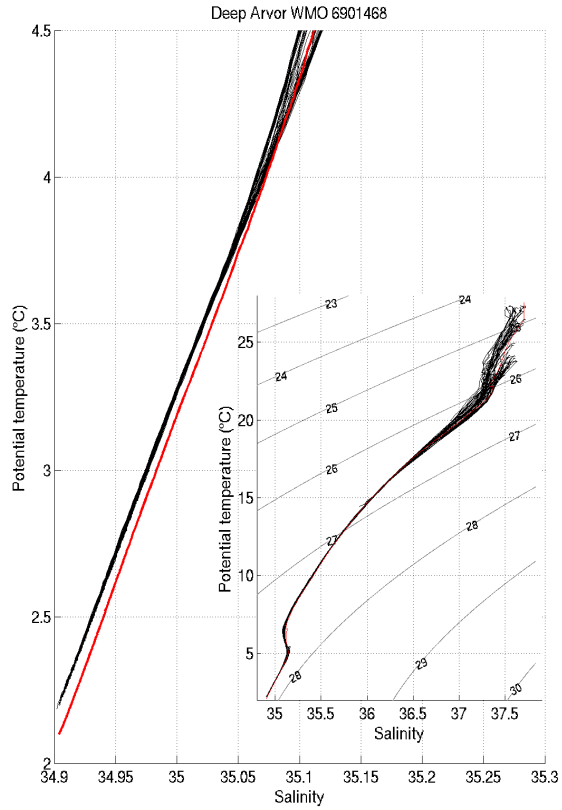
JAMSTEC group (Deep Ninja):

- Float salinity measurements were deviated from shipboard reference.
- The salinity bias, besides an offset component for some floats, had a pressure dependence component which makes the deeper measurements fresher.
- *But causes are not identified.*



NAOS group (Deep Arvor):

- Using ship CTD reference profiles, we detected a fresh bias for SBE41CP of o(0.01-0.02)
- Using OW method the bias is detected only considering the deep layers (<3000m)
- Bias is not pressure-dependent



Salinity measurements of SBE41CP are apt to become stable after initial adjustments

If a reference is available, pressure dependency and offset are fixed with it

Deep Argo Pilot Arrays
North Atlantic

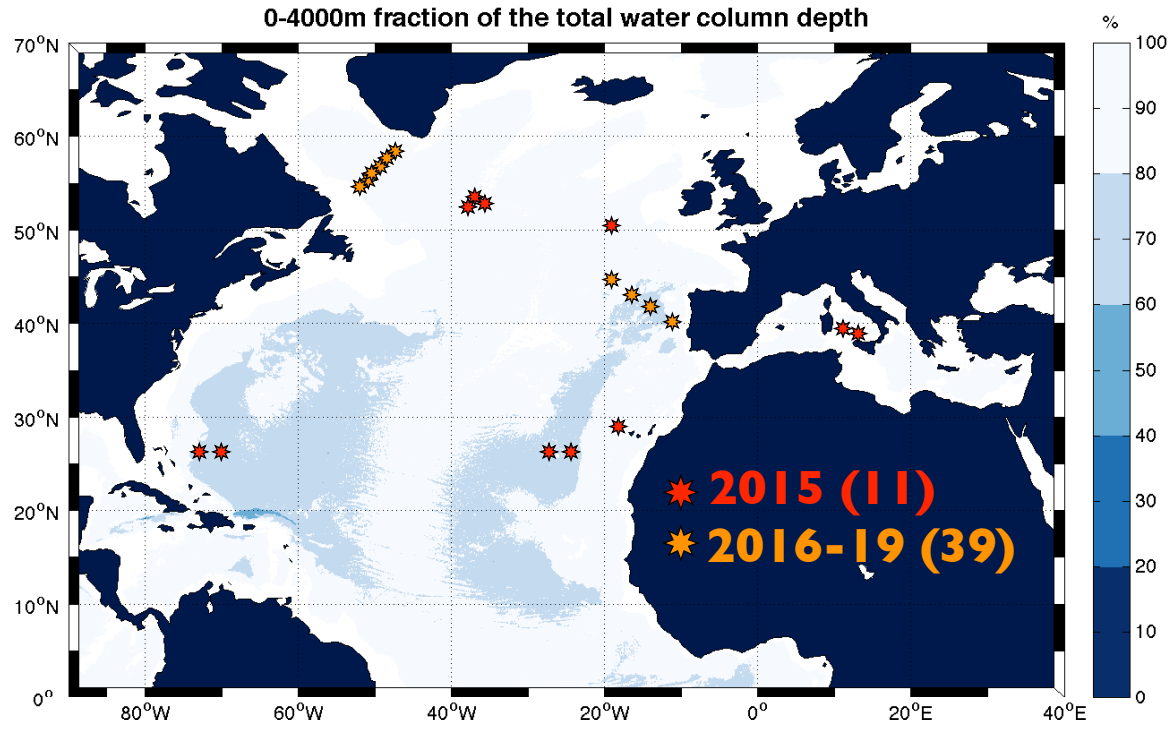
France-NAOS with Euro-Argo coordination

2015: plan to deploy **11 floats**
- 4 Deep Arvor (NAOS); 1 in West European Basin + 3 in the Charlie-Gibbs Fracture Zone (France) in June
- 2 Deep Arvor and 2 Deep Apex; Deep western and eastern Atlantic at 26N (UK) in December
- 2 Deep Arvor; Mediterranean Sea (Italy)
- 1 Deep Arvor; Canary Island (Spain)

2016: Plan to deploy **8 Deep Arvor** (NAOS)

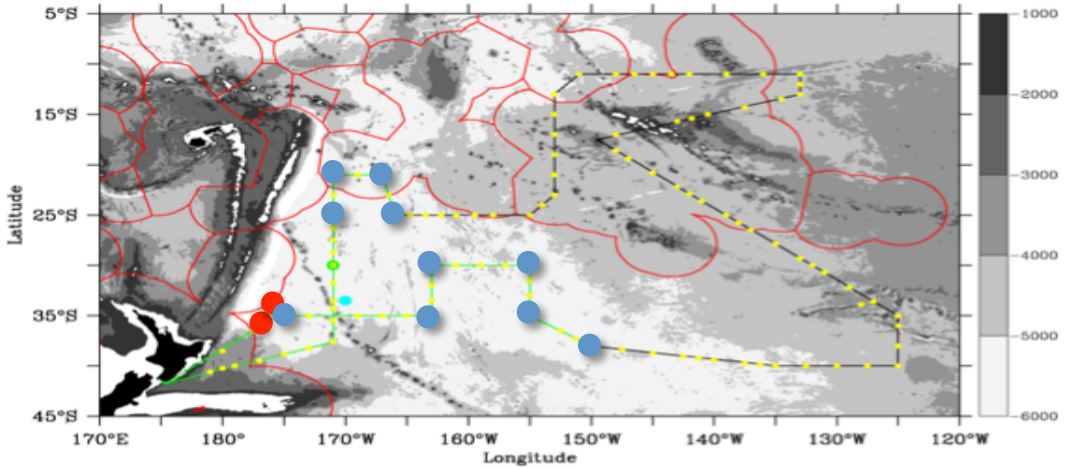
2017: Plan to deploy **12 Deep Arvor** (NAOS) in subpolar gyre and **8 Deep Solo** at 26N (US/UK)

France Scientific goal: To study the interannual variability of the formation and circulation of deep water-masses formed by deep convective events in the subpolar gyre of the North Atlantic

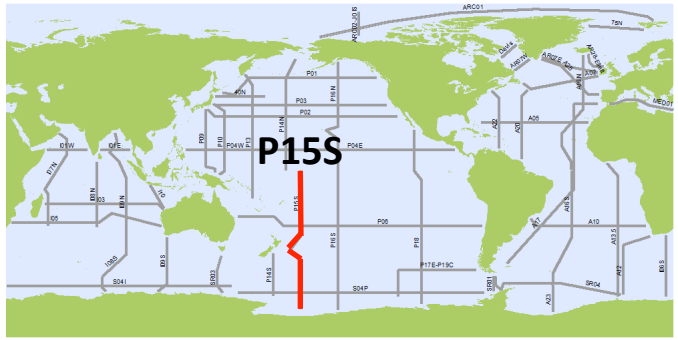


Deep Argo Pilot Arrays Southwest Pacific

USA/SCRIPPS & Aust./CSIRO coordination



- **Deep Argo float deployment**
- **Deep Argo float recovery**
- **Core Argo float deployment**



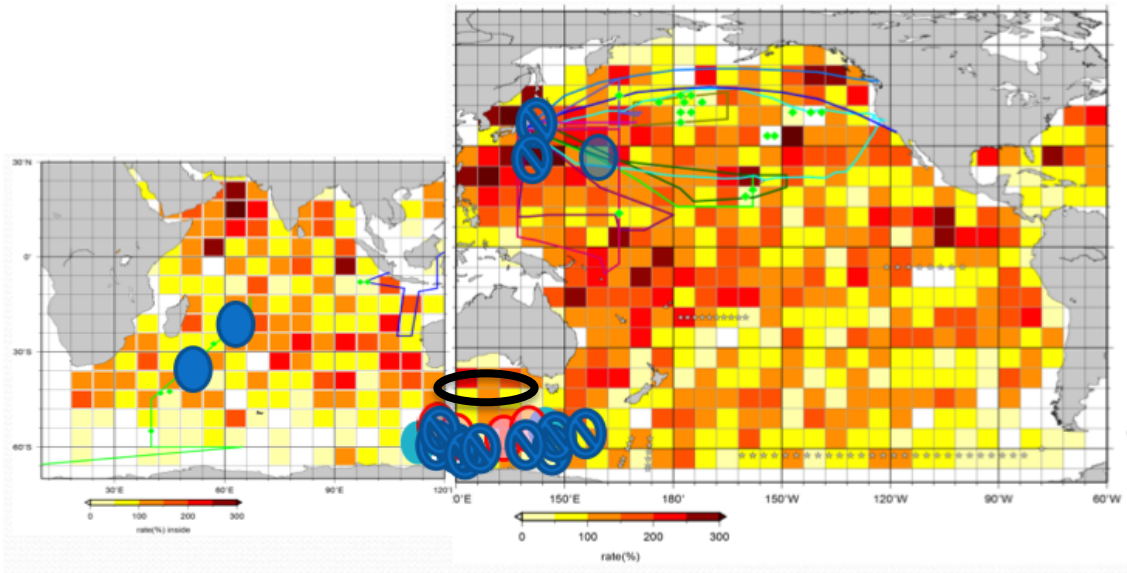
2015 Plan to deploy: 0. Recover 2 Deep SOLO floats deployed in 06/2014. Recovery of Deep SOLOs is for CTD recalibration and possible recycling, and for assessment of wear and tear on pump, glass ball, etc.

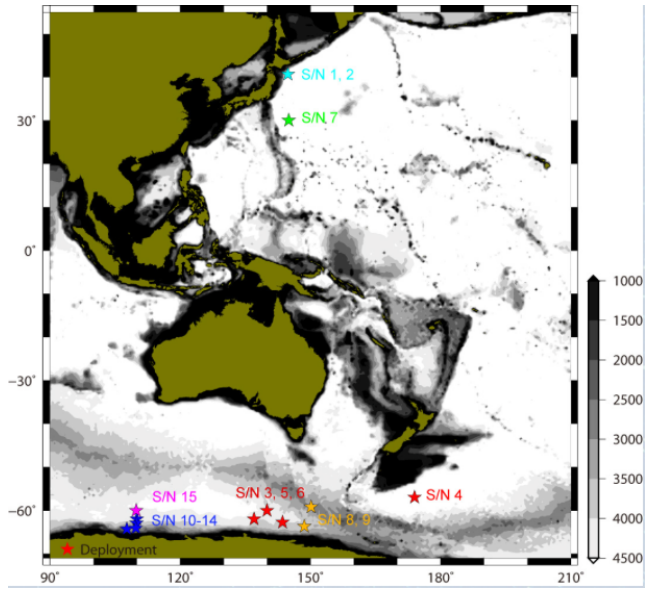
2016 Plan to deploy 12 Deep Argo floats: 8 Deep SOLO (US) and 2 Deep APEX (US) in 01-02/2016 in the SW Pacific onboard RV Kaharoa and 2 Deep SOLO in 02-03/2016 at 170°W (P15S) onboard RV Investigator.

Scientific Goal: To study deep watermass characteristics and identify watermass pathways in the SW Pacific Ocean with greater detail.

Deep Argo Pilot Arrays
North Pacific, Southern Ocean, Indian Ocean

Jamstec coordination





15 Deep (4000m) NINJA (Japan) deployed in 2012-2014; 3 in the North Pacific Ocean (engineering testing) and 12 in the Southern Ocean (1 south of NZ; 5 off the Adelie coast; 6 off the Budd coast). 3 (possibly 5?) Deep NINJA currently active under sea ice.

Plan to deploy **3 Deep NINJA** (Japan) between 11/2015 and 03/2016; 1 in the North Pacific Ocean and 2 in the Indian Ocean

Plan to deploy **8 Deep SOLO** (US) in 06/2016 in the Southern Ocean (possibly Australian Basin ⬭).

Scientific Goal: Study water mass formation and deep Meridional Overturning Circulation

Workshop recommendation

It is a priority to succeed in:

- deploying pilot arrays and
- demonstrate their scientific added values

> to prepare Ocean Obs'19

At the french level,
10% of the global straw plan means 60 floats at sea.
= in agreement with 15 floats/yr (CPER)

We advocate for the same ratio at the european level

North Atlantic pilot array is the most advanced and ambitious