



IOC/INF-1344
Paris, 18 June 2017
Original: English

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION
(of UNESCO)

INFORMATION DOCUMENT

EVOLVING CAPABILITIES OF THE ARGO PROFILING FLOAT NETWORK

Summary. Argo is a major contribution to the Global Ocean Observing System, and its initial development over the past 15 years represented a revolution in the collection of climate information in the global ocean, as well as a revolution in the culture of free and open data sharing amongst oceanographers. The capabilities of Argo are evolving, and this information document serves to transparently let IOC Member States know how it is changing, how they can participate, and how they can benefit.

Achievements of Argo as a contribution to GOOS

1. 93% of the excess heat in the climate system between 1971 and 2013 found its way into the ocean. The ocean therefore plays a crucial role in determining the climate of the planet, and monitoring the ocean is monitoring the Earth's climate. About half of historical anthropogenic carbon emissions have been absorbed by the ocean, reducing the amount of greenhouse gases and therefore the temperature in the atmosphere. This carbon is the source of ocean acidification. Climate change is also leading to a growth in low-oxygen areas of the ocean through changes in ocean circulation, stratification, and air-sea exchanges.

2. The ocean is a challenging environment to observe, and historically ship-based ocean sampling left large expanses unobserved for long periods of time. Argo profiling floats are 2 m-long, freely-drifting robotic devices that adjust their depth in the ocean by changing their buoyancy. In Argo, they are programmed to 'park' at 1000 m depth, regularly diving to 2000 m, and then rising to the surface to measure a profile of ocean variables from sensors on top of the float. At the surface the data are transmitted by satellite, and the floats then descend back to their parking depth. At present, 3900 Argo floats are reporting data regularly.

3. A recent review¹ highlighted the major contribution of Argo to the Global Ocean Observing System (GOOS) over the past 15 years. We are now for the first time routinely monitoring the upper 2000 m of the ocean globally and uniformly in space and time. The network provides freely available profile data from all floats, within 24 hours of collection. These data are used in a broad range of applications examining climate-relevant variability on seasonal to decadal timescales, multi-decadal climate change, improved initialization of coupled ocean–atmosphere climate models, and constraining ocean analysis and forecasting systems. More than 2100 refereed science papers have been published using Argo data.

4. Argo profiles are used in combination with high quality repeat hydrography from research vessels, moored observations, satellite altimetry, XBT surveys, to provide a sustained systematic view of the global ocean.

Institutional context

5. As a major contribution to the Global Ocean Observing System (GOOS), Argo remains a voluntary and independent network organized under the Argo Steering Team. GOOS is a creation of and governed by the Intergovernmental Oceanographic Commission of UNESCO, and co-sponsored by the World Meteorological Organization, the United Nations Environment Programme, and the International Council for Science. A representative of the Argo Steering Team is a member of the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) Observations Coordination Group, and the Argo Information Centre (AIC) is housed in the JCOMM Observing Programme Support Centre (JCOMMOPS).

Deployment of floats and drift into waters under national jurisdiction: application of IOC Resolutions

XX-6 and EC-XLI.4

6. At the intergovernmental level, the Argo programme was formally accepted and defined by IOC Resolution XX-6 (1999). The resolution also considered that Argo be "fully consistent with the UN Convention on the Law of the Sea." In 2005, the IOC Assembly instructed IOC's Advisory Body of Experts on the Law of the Sea (ABELOS) to address the deployment of floats on the high sea which may drift into EEZs.

¹ Riser et al., 2016, *Fifteen years of ocean observations with the global Argo array*, Nature Climate Change, doi:10.1038/nclimate2872

7. In 2008, the IOC Executive Council passed a resolution (IOC/EC-XLI.4): "Guidelines for the Implementation of Resolution XX-6 of the IOC Assembly Regarding the Deployment of Profiling Floats in the High Seas within the Framework of the Argo Programme" which adopted a practical set of guidelines for notification of coastal states that is used today with success, with the involvement of the Argo Information Centre at JCOMMOPS. At the time, some Argo floats were already piloting the measurement of other variables, such as oxygen, in addition to the temperature and salinity of its core mission.

8. The Argo Information Centre was established in 2001 within JCOMMOPS to provide international and technical coordination for the Argo program, and implement in particular the requirements of Resolution XX-6. An electronic notification procedure was implemented by the AIC to inform all Member States through their designated Argo National Focal Point (NFP), of all deployments of Argo profiling floats. IOC Member States were recently requested to update their Argo NFP through IOC Circular Letter 2666 (1 June 2017).

9. Practically, Argo implementers register their deployment plans at the AIC, which triggers an electronic notification sent to the NFP, from 6 months in advance to a few days after the deployment, when reliable information is received from the ship performing the deployment. The AIC enforces this procedure as a *sine qua non* condition for a profiling float to be considered an Argo float, along with free and unrestricted data sharing.

10. Following up on Resolution IOC/EC-XLI.4, an additional notification system was set up to meet the requirements of Member States requesting a formal notification from the implementer when an Argo float approaches their Maritime Zone. The following Coastal States have sent official request for such notification to the IOC secretariat: Argentina, Brazil, Chile, China, Ecuador, Egypt, Greece, India, Peru, Tunisia and Turkey.

11. Whenever a profiling float approaches a Maritime Zone under the sovereignty of one of the above Coastal States, an email is sent to the platform operator (national Argo programme manager) by the AIC, with all the information needed to formally notify the coastal state. A factual pdf report is generated, including core metadata (as requested by the guidelines), including a sensor list, attached to an email along with details of the NFP, so that the implementer can easily notify the Coastal State. These are logged and available on the argo.jcommops.org website. Implementers have to acknowledge receipt of the report, and will keep receiving reminders as long as they do not acknowledge receipt. Reports are only generated for the first time a particular float enters the maritime zone of a coastal state.

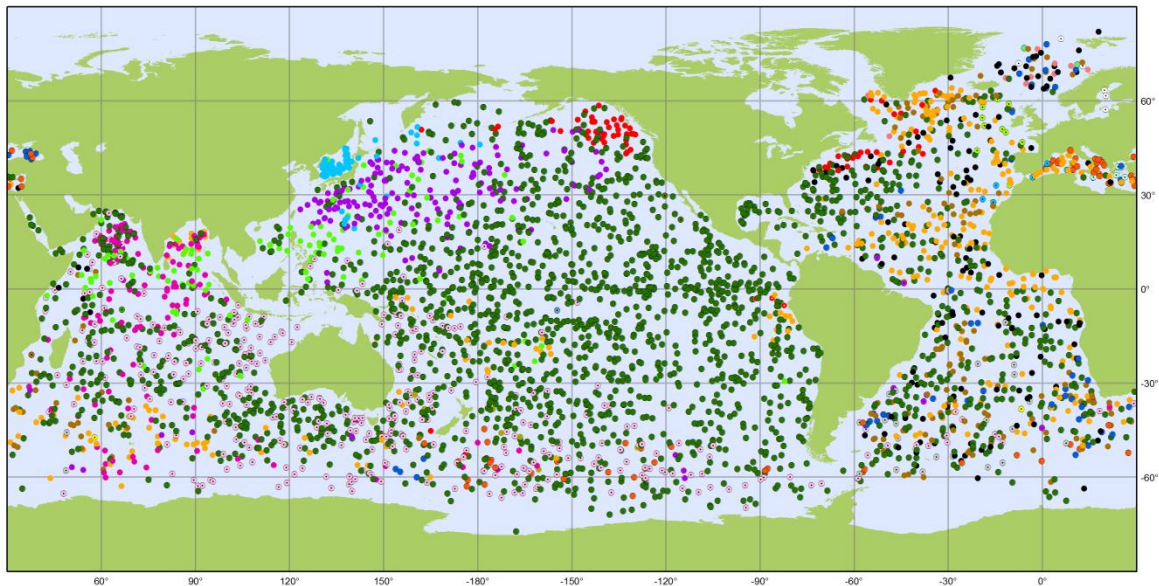
12. The experience developing the present-day Argo notification scheme for EEZs responds to national interpretations of the United Nations Convention on the Law of the Sea. The trust built up over the years has led to a situation where a number of countries request notification, but so far, no country has ever asked that Argo data be turned off within its EEZ.

Additional Services provided by JCOMMOPS/AIC

13. Argo floats are monitored in real-time by JCOMMOPS/AIC from early planning to end of life, and all information on the program, including how to access data, are available on argo.jcommops.org. This website can be easily customized for individual national needs, e.g., to monitor one Exclusive Economic Zone in particular.

14. Argo implementers are regularly informed on their duties, including the need to fully comply with UNCLOS for deployments directly into EEZs. A number of Member States have explicitly and globally agreed to deployment of Argo floats within their EEZ, provided floats are properly notified via the AIC/JCOMMOPS and data made freely available.

15. Specific reports are sent on demand to Member States for a detailed survey on their Maritime Zones. The Centre acts as a clearing house on any issue arising on the Argo program.

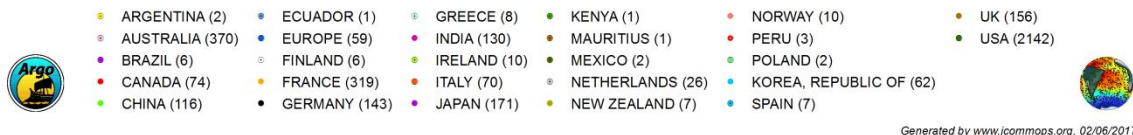


Argo

National contributions - 3904 Operational Floats

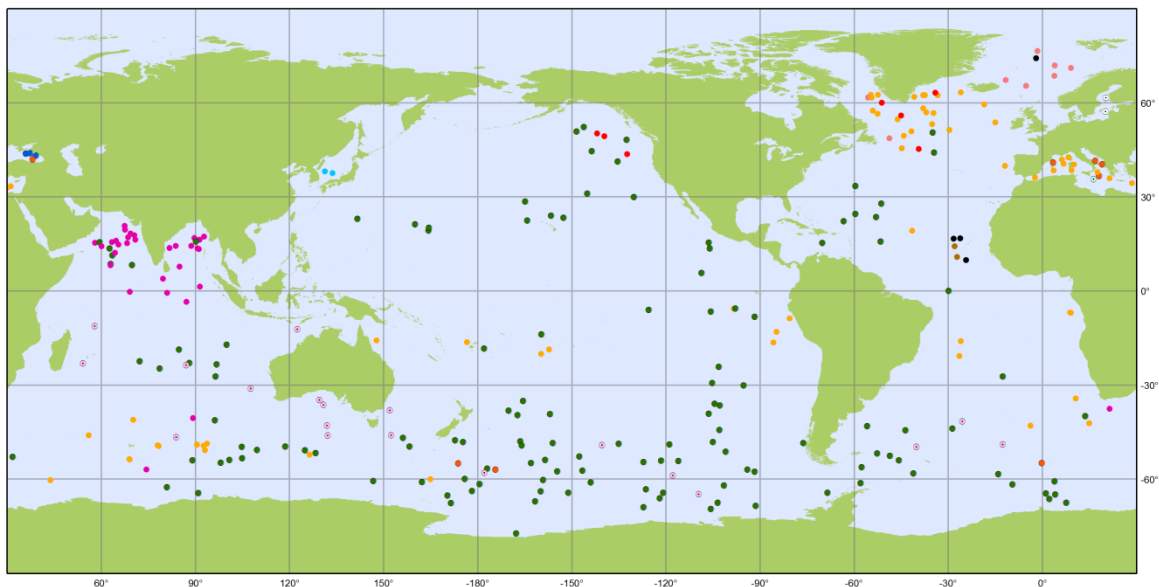
May 2017

Latest location of operational floats (data distributed within the last 30 days)



Generated by www.jcommops.org, 02/06/2017

Latest Status of Global Argo Program as of May 2017



Argo BioGeoChemical

National contributions - 284

May 2017

Latest location of operational floats (data distributed within the last 30 days)



Generated by www.jcommops.org, 02/06/2017

Latest Status of biogeochemical sensors on Argo floats as of May 2017 (7%)

Evolving capabilities of the Argo float network: new sensors, new depths

16. As of May 2017, 284 of the 3904 operational floats (7%) tracked by the AIC/JCOMMOPS measured one or more biogeochemical variables. These were distributed in all of the world ocean.

17. A *Biogeochemical-Argo Science and Implementation Plan* (2016, doi:10.13155/46601) builds on many years of research and sensor development, which now allow profiling floats to also observe biogeochemical properties with sufficient accuracy for climate studies. The Plan identifies the potential benefits of Biogeochemical-Argo as enabling "an observing system that can determine the seasonal to decadal-scale variability in ocean biological productivity, the supply of essential plant nutrients from deep waters to the sunlit surface layer, ocean acidification, hypoxia, and ocean uptake of CO₂. Biogeochemical-Argo will drive a transformative shift in our ability to observe and predict the effects of climate change on ocean metabolism, carbon uptake, and living marine resource[s]." The Plan calls for a 1000 float array, with global deployment, measuring six additional variables in addition to temperature and salinity: pH, oxygen, nitrate, chlorophyll fluorescence, suspended particles, and downwelling irradiance. Biogeochemical-Argo will also have transparent and public protocols, real-time data access and products, international coordination, entrainment of early career scientists, and outreach and capacity development.

18. Other pilot Argo activities have tested passive acoustic listeners, which provide information on wind, rainfall at the surface, marine mammals, and seismic activity. As of May 2017, 17 operational floats carried passive acoustic sensors.

19. Deep Argo floats have been developed to profile to 6000 m depth, and these floats will be deployed in greater numbers in the future.

20. The Argo data flow was reviewed in depth to take into consideration this evolution and make sure all data including new data streams are and continue to be freely available.

21. The current notification procedure outlined in paragraphs 7-12 above is being applied for multidisciplinary floats. So far, no Member State has shown any concern after receiving notifications including multidisciplinary sensors.

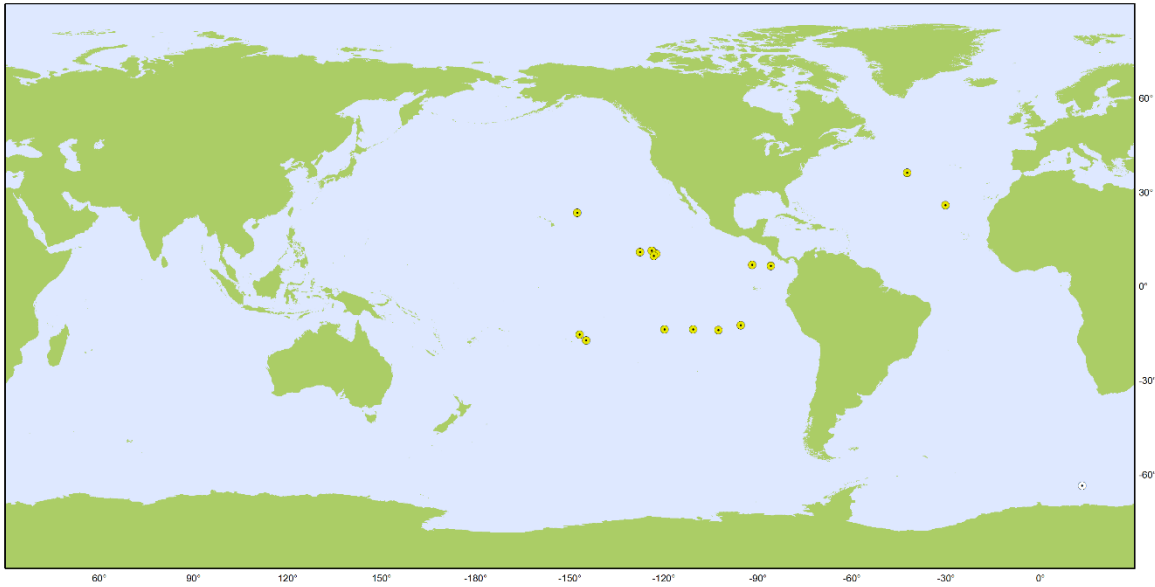
Transparency and openness

22. This evolution of Argo capabilities is brought to the attention of IOC Member States based on strong principles of transparency and openness, and with a desire to enter into constructive dialogue regarding any concerns that may be triggered, and a desire to ensure that all IOC Member States can fully participate in and benefit from Argo in the context of GOOS.

23. The design of the Argo array was recently reviewed and it is proposed that it be enhanced to cover high latitudes and marginal seas. In practice, 30% of the Argo float network design is in waters under national jurisdiction, and it will be impossible for Argo to achieve its vision without strong engagement with all Coastal States, including support to facilitate deployments directly into EEZs while respecting the Law of the Sea.

29th IOC Assembly

24. This document has been prepared as further background to the information contained in the Action Paper (document IOC-XXIX/2 Prov.), including a proposed decision referenced IOC-XXIX/Dec.6.1.1. Member State views are actively sought, and they may decide to, as the proposal suggests, note this information, or may decide to establish a mechanism for further dialogue with Argo and GOOS.



Argo

Argo - Misc. Sensors

May 2017

Latest location of operational floats (data distributed within the last 30 days)

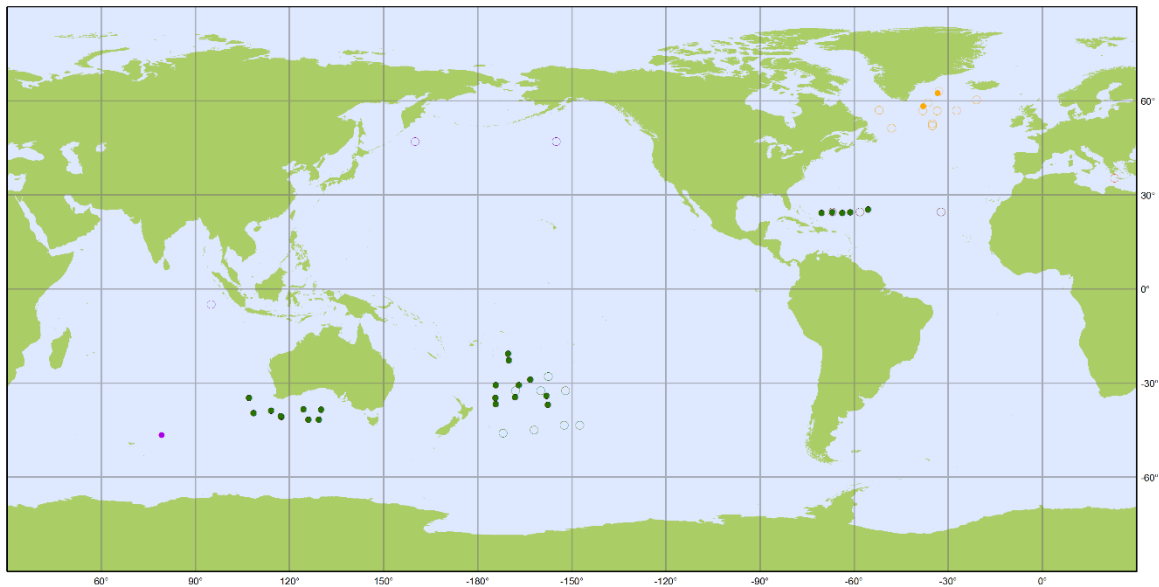


- PAL (16) (Passive Acoustic Listener (Ambient sound field recording))
- RAFOS (1) (Delayed-mode under-ice localization via acoustic receiver)



Generated by www.jcommops.org, 02/06/2017

Latest Status of other sensors as of May 2017



Deep Argo

National contributions - 28

Operational Floats

May 2017

Latest location of operational floats (data distributed within the last 30 days)

Operational Floats Deployment Plans

- | | |
|--------------|---------------|
| ● EUROPE (0) | ○ FRANCE (17) |
| ● FRANCE (2) | ○ ITALY (1) |
| ● JAPAN (1) | ○ JAPAN (3) |
| ● USA (24) | ○ UK (3) |
| | ○ USA (8) |



Generated by www.jcommops.org, 02/06/2017

Deep Argo floats as of May 2017

Intergovernmental Oceanographic Commission (IOC)
United Nations Educational, Scientific and Cultural Organization
7 place de Fontenoy
75 732 Paris Cedex 07, France
Tel.: +33 1 45 68 10 10
Fax: +33 1 45 68 58 12
<http://loc.unesco.org>