ARGO-ITALY: TECHNICAL AND SCIENTIFIC DESCRIPTION

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1. Technical description

The Argo programme is the most important in-situ component of the Global-Ocean Observing System. Argo is based on about 4000 floats distributed in the global ocean (figure 1).

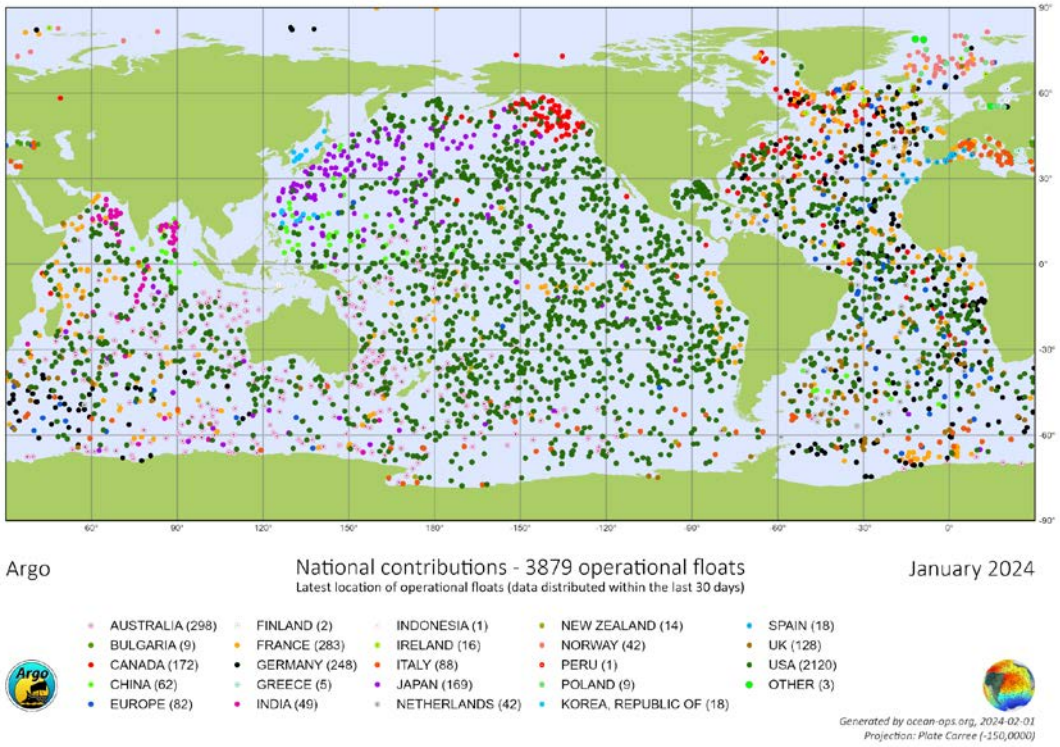

Figure 1. World wide distribution of active Argo floats as of January 2024.

A float is an autonomous platform capable of regulating its buoyancy that, after being deployed in the ocean, is parked at 1000 m (in the open ocean) where it drifts with currents. Every 10 days (or less in Marginal Seas), the float rises to the surface while collecting measurements that are transmitted to shore via a satellite link (figure 2). Argo data are then automatically processed and made freely available in near real time to scientific users and operational oceanographic centers. Argo is one of the most cost-effective ways to monitor the ocean interior on a long-term basis.

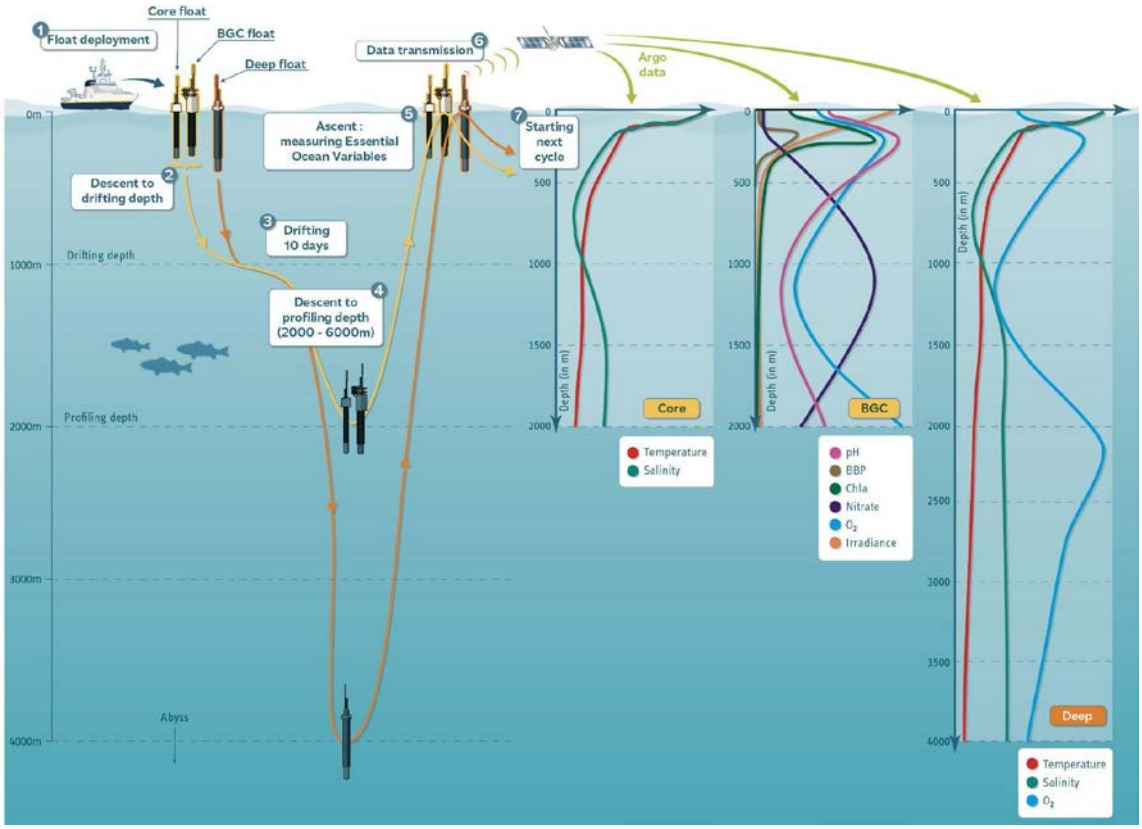

Figure 2. Typical cycle and measured parameters of the three Argo float types: Core-Argo, BGC-Argo and Deep-Argo.

Argo is divided into three missions: Core-Argo, Deep-Argo and Biogeochemical Argo. Core-Argo and Deep-Argo focus on collecting profiles of temperature and salinity between 2000 (Core-Argo) or 6000 m (Deep-Argo) to the surface. Biogeochemical Argo (BGC-Argo), besides temperature and salinity, adds six biogeochemical variables: dissolved oxygen, nitrate, pH, chlorophyll fluorescence, suspended particles, and downwelling light.

1.1 Argo-Italy

Argo-Italy is the Italian contribution to the international Argo programme and is an Italian Research Infrastructure that since 2014 also contributes to the Euro-Argo European Research Infrastructure Consortium (Euro-Argo ERIC).

The MUR has recognized Euro-Argo ERIC as a high priority infrastructure for the Piano Nazionale Infrastrutture di Ricerca (PNIR 2021-2027) which is an integral part of the Piano Nazionale di Ricerca (PNR). **The annual effort sustained by the Italian ministry guarantees the contribution to the European and worldwide infrastructure following the guidelines that emphasize the importance of maximum space-time coverage through Core-Argo floats. As internationally recognised the highest priority is to sustain the Core-Argo array (ideally with oxygen) while maintaining limited regional pilot arrays for Deep and BGC Argo**.

Argo-Italy focuses its activities in the Mediterranean Sea that is one of the main "hot-spots" of climate change and is known to respond to climatic changes with amplified signals. Additional regions of interest are the Black Sea and the Southern Ocean including the Ross Sea.

a. Platforms

Argo-Italy is an autonomous and integrated system of multidisciplinary marine observations mainly carried out by profiling buoys (Argo, see the platform description in chapter 1). Surface drifters, and ocean glider activities are included to a much lesser extent to complement monitoring activities. Italy has assumed the role of coordinator of drifter activities for the Mediterranean and the Black Sea and also in the tropical Atlantic and has participated in international campaigns with gliders (integrated into EGO - Everyone's Gliding Observatories).

- **Profiling floats**

  Profiling floats are autonomous platforms capable of regulating its buoyancy that, after being deployed in the ocean, is parked at 1000 m (in the open ocean) and 350 m (in the Mediterranean Sea, where they drift with currents. Every 5-10 days (in the mediterranean sea and Marginal Seas respectively), floats rise to the surface while collecting measurements that are transmitted to shore via a satellite link.

- **Gliders**

  Gliders are autonomous underwater vehicles (AUV) that use changes of their buoyancy to move along the water column in the ocean in order to collect physical and biogeochemical ocean properties. Wings are used to convert vertical displacement into

horizontal motion, resulting in a vertical sawtooth dive reaching 1000 m depth, and a horizontal speed of about 1 km/h. Compared to traditional shipboard techniques, gliders provide a large amount of data on a finer temporal and spatial scale, with very low power consumption and management costs.

- **Drifters**

  Drifters are lagrangian buoys that remain at surface following the local current and transmitting the surface temperature and GPS position. Measurements are generally taken every hour, and the batteries provide power for almost 2 years. Over the years, various types of drifters have been developed to meet oceanographic and scientific needs.

2. Scientific description

a. Objectives

The overall aim of Argo is to understand the ocean's role in Earth's climate to be able to make improved estimates of how it will change in the future.

Specific objectives are:

- To measure the ocean heat content;
- To measure changes in sea level;
- To understand changes in global rainfall patterns by measuring changes in salinity;
- To better understand changes in the ocean carbon, oxygen and nutrient cycles;
- To investigate the dynamics of oxygen minimum zones, ocean acidification, phytoplankton communities and the biological carbon pump;
- To investigate and explore the ocean.

b. Argo achievements

- Argo is uniquely suited to observe our changing climate and is a key player in addressing societal challenges linked to sea level rise, ocean heat content and warming, and circulation.

- Using Argo measurements, scientists have dramatically improved estimates of the ocean heat content and can now calculate how and where ocean heat content is changing. Since seawater expands as it warms, its contribution to sea level rise can also be estimated.
- In addition, Argo observes the ongoing intensification of the water cycle as the planet heats up. Warmer air stores and transports more water, so dry areas of the world have increased evaporation while wet places have higher precipitation. Argo observations of upper ocean salinity show that relatively salty (high evaporation, low precipitation) areas of the ocean are getting saltier while fresh (low evaporation, high precipitation) areas are getting fresher.
- Real-time Argo data are used by operational weather forecasting centres around the world to improve weather forecast and climate predictions. Profiling floats deployed in the tropical oceans during cyclone season, enable improved storm-intensity forecasts.

c. Objectives of Argo-Italy

- To strengthen the Italian role in ocean observation at international level.
- To contribute to the international Argo programme by maintaining and strengthening the Core-Argo fleet.
- To contribute to the international Argo programme by implementing quality-control procedures and providing high-quality data to the Argo Global Data Assembly Centres.
- To study the deep Mediterranean waters, their properties and circulation, by deploying Deep-Argo floats in the Mediterranean Sea.
- To strengthen physical and biogeochemical observations by adding oxygen sensors to all Core-Argo floats.
- To monitor and investigate the health of marine ecosystems, and the dynamics of biogeochemical cycles by deploying BGC-Argo floats (ITINERIS-PNRR project).
- To support the international BGC-Argo programme by testing alternative sensors (e.g., for nitrate, suspended particles) on Italian floats (ITINERIS-PNRR project).
- To contribute to developing and testing new biogeochemical sensors and new sampling strategies (ITINERIS-PNRR project).
- To support physical and biogeochemical operational ocean forecasts in the Mediterranean Sea.