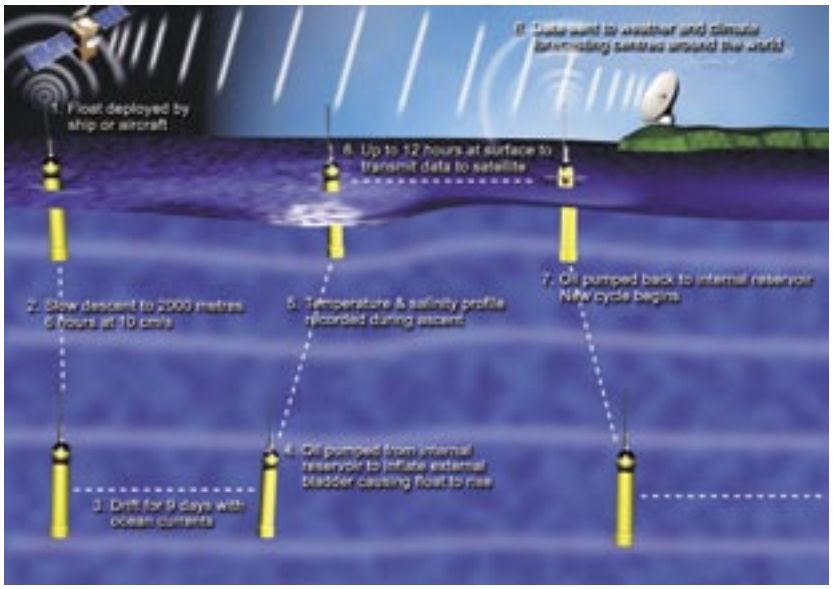
Monitoring the ocean climate with Argo floats



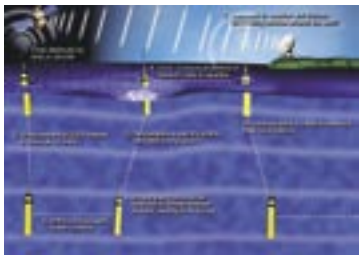


Figure 2. Deployment of an Argo float from the research vessel "Johan Hjort".

The ocean climate has traditionally been monitored with measurements from ships. Research vessels, advanced instruments and skilled technical personnel are then needed to acquire high quality data. Observations from ships are also weather and ice dependence that results in that more observations are taken during summer than winter. Collecting oceanographic data of high quality are therefore both time and effort consuming which again is a limited factor for the quantity. In addition to this it can also take a long time before the data reach the scientists. The last decades satellites have been used to monitor the ocean state but they have the restrictions that they only monitor the ocean state at the surface, for instance the sea surface temperature. The need for systematic and real time monitoring of the ocean climate in the upper 2000 meters has resulted in an increased attempt to use new technology. This is the origin of the Argo project where the aim is to deploy 3000 free-drifting floats in the world ocean.

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Argo floats

An Argo float is a float that drift passive with the ocean currents at a chosen depth, usually at 2000 meters depth. The float is battery driven and is programmed such that it every tenth day ascends to the surface (Figure 1). During the ascent it measures pressure, temperature and salinity (i.e. a vertical profile of temperature and salinity). When it reaches the surface the data together with its position are sent to land via satellite. The positions to a float are used to measure the ocean currents at the reference depth. After data are sent it will descend to its reference depth until it repeats its cycle after 10 days. The float is constructed to have the same density as the water at the reference depth. The ascent occurs by a pump that moves oil from inside the pressure case to a bladder on the outside. The bladder inflates and the volume increases. As the mass remains the same its density decreases and the float ascends. When the float descends the opposite occurs: oil is pumped back into the pressure case. The Argo float is 40 kg, 1.3 meter long, 20 cm in diameter and has a lifetime of about 4 years. It can be launched into the ocean from both ships and aircrafts (Figure 2). For most Argo floats the data are transmitted via the Argos data transmission system. The satellites of the Argos system look down on all Argos transmitters within a 5000-km-diameter circle and they transmit data to ground stations from their altitude of 850 km. The data transmission rates are such that to guarantee error free data reception and location in all weather conditions the Argo float must spend between 6 and 12 hours at the surface. The float positions are

accurate to ~100 meters depending on the number of satellites within range and the geometry of their distribution. Data from all the Argo floats are in near real-time freely available over internet.

100 000 temperature and salinity profiles every year

The aim of the Argo project is to have 3000 Argo floats globally distributed. This will give us yearly about 100 000 vertical profiles of temperature and salinity! The deployment of Argo floats started in year 2000 and at present there are about 1470 floats drifting in the ocean (Figure 3). 19 countries have so far contributed with Argo floats. The goal with 3000 floats will probably be achieved in 2006. Several weather and climate centres all over the world use the Argo data to understand how the ocean influences the climate. The data are, for instance, used to initialise climate models for seasonal and inter annual predictions and to increase prediction of larger periodic climate events such as the El Niño.

Argo floats in the Nordic Seas

At present there are 15 Argo floats drifting in the Nordic Seas (Norwegian, Greenland and Icelandic Seas). The floats are deployed from institutions in Norway, Denmark, Germany and England. With these floats we now get regular measurements from areas that are poor covered with research cruises. Also, of great importance, is that we now get new knowledge about the ocean currents in deep waters. An example of results from an Argo float is shown in Figure 4. The figure shows the current at 1500 meters depth from one of nine Argo floats that Institute of Marine Research, Norway have deployed. The mean speed of the float, and then also of the ocean current, is 6.6 cm/s while maximum speed was measured to 15.8 cm/s. This is the first time direct measurements show that the current in the deep ocean current is cyclonic (counter clockwise) in this area.

Argo floats in the future

The Argo floats give us an opportunity to continuously monitor the ocean climate in near real-time. At present Argo floats cannot only contain pressure, temperature and salinity sensors but also oxygen, optical and acoustic sensors. Some floats can also measure wind and precipitation when they are at the surface. Instrument developments in the near future will give more advanced Argo floats with several new sensors. The floats could also be equipped with wings, like a submarine sailplane, such that itself can change its position during descent and ascent. It will also be possible to give commands to the Argo floats with a two-way satellite communication. An alternative system to Argos has already been tested using positions from the Global Positioning System (GPS) and data communication using the Iridium and Orbcomm satellites. This allows more detailed data profiles to be transmitted with a shorter period at the surface and even two-way communication. For more information about the Argo floats see the internet home page to the Argo project (www.argo.ucsd.edu).

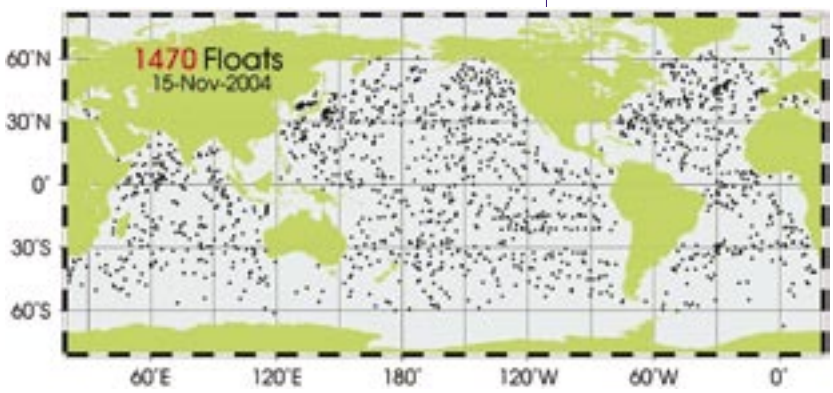

Figure 3. Overview of all Argo floats that have sent data last 30 days.

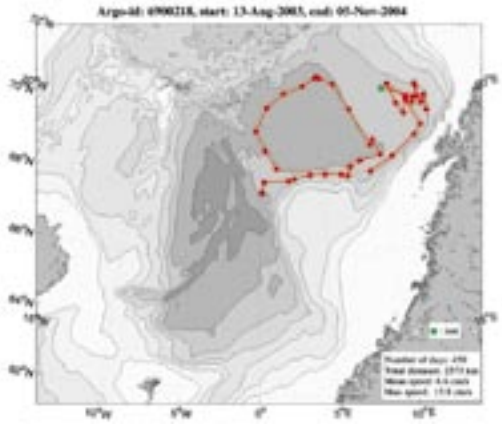

Figure 4. Trajectory path to an Argo float that Institute of Marine Research, Norway deployed in August 2003. There are 10 days between each point. Red point with blue circle indicates first position (14 August 2003) while green point is last position (5 November 2004).

The name Argo

The name Argo has its origin from greek mythology. Jason, a king- son from Iolkos in Thessalia, used the ship Argo on the search for the golden fleece. The crew onboard was called Argonauts, and they had many adventures. Thus, the Argo floats sails in the 21st century seas. The most important partner to the Argo project is the Jason project where the sea surface level are measured from the JASON-1 satellite. By combining the data from Argo and Jason one can measure the ocean currents, oceanic heat and salt transports, and sea level rise.