

GREEK ARGO PROGRAMME

PRESENT STATUS AND FUTURE PLANS

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1. Background and organization of GREEK ARGO activities

Greece has established a national contribution to the ARGO project through national funding to the Greek Argo programme (2012-2015). The programme was co-financed by Greece and the European Union.

1.1 Deployed floats

During the period November 2013-July 2015, 12 Argo floats were successfully deployed in the Greek Seas in the framework of the Greek Argo Project. During the second half of 2014, 4 deployments were accomplished by the Greek-Argo team. The 4 floats were purchased by the Greek Argo RI and were deployed in the North, Central, South Aegean and South Ionian accordingly. The floats integrate an Iridium satellite telemetry system which provides a dual telecommunication capability allowing modification of the configuration in real-time, while the one in Central Aegean comprises an additional Dissolved Oxygen sensor. The first Argo NOVA float (WMO number: 6901884) was deployed at the 7th of October of 2014 at the Northern Aegean, near Athos. Next day, the second NOVA float (WMO: 6901885) was deployed at the northwestern part of the Cretan Sea. About one month later, at 12 November 2014, a DOVA float (equipped with dissolved oxygen sensor) was deployed in the Myrtoan Sea, east of the Hydra Island. This one (6901886) was the second float equipped with dissolved oxygen sensor that was ever deployed in the Greek Seas, aiming to give better insight to ecosystem's dynamics of the region. One day later, at 13 November 2014, another NOVA float (6901887) was released off the coast of Pylos, in southwestern Peloponnese. During 2015, 5 additional successful deployments have been accomplished by the Greek Argo Infrastructure. The first is a DOVA float (6901888) and was deployed at the 3rd of July 2015 in the Northern Aegean, near Athos peninsula. Next day (4 July 2015) the NOVA float 6901890 was deployed in the Northern Aegean, west of Mytilene Island. Later this day the DOVA float 6903152 was released off the southwestern coast of Chios Island in the Central Aegean. At the 7th of July of 2015 the NOVA float 6901889 was deployed in the Cretan Sea, northwesterly of Heraklion port. Finally, a PROVOR CTS3-DO was re-deployed 20 km south of Central Crete. The float had initially been deployed in the center of the Cretan basin on the 30th of October of 2013. The float was purchased under PERSEUS FP7 project and deployed under the coordination of the Greek Argo National Infrastructure.

The deployments during 2015 are presented in the table 1 and in figure 1:

Table 1. Deployments performed from Greek Argo team during 2015

	FLOAT TYPE	WMO	IMEI NUMBER	SERIAL NUMBER	DEPLOYMENT DATE	DEPLOYMENT TIME	LAT	LON	STATUS
1	NOVA OXYGEN	6901888	300234062720330	169	3/7/2015	18:30	40° 02'	24° 37'	MALFUNCTION
2	NOVA	6901890	300234061667320	140	4/7/2015	1:00	39° 13'	25° 05'	ACTIVE
3	NOVA OXYGEN	6903152	300234062729330	170	4/7/2015	9:00	37° 55'	25° 38'	ACTIVE
3	NOVA	6901889	300234061663020	138	7/7/2015	18:00	35° 55'	25° 20'	ACTIVE
4	PROVOR CTS3 DO	6903153	Argos transmission	OIN12GRS3DO	17/7/2015	14:00	34° 45'	24° 45'	ACTIVE

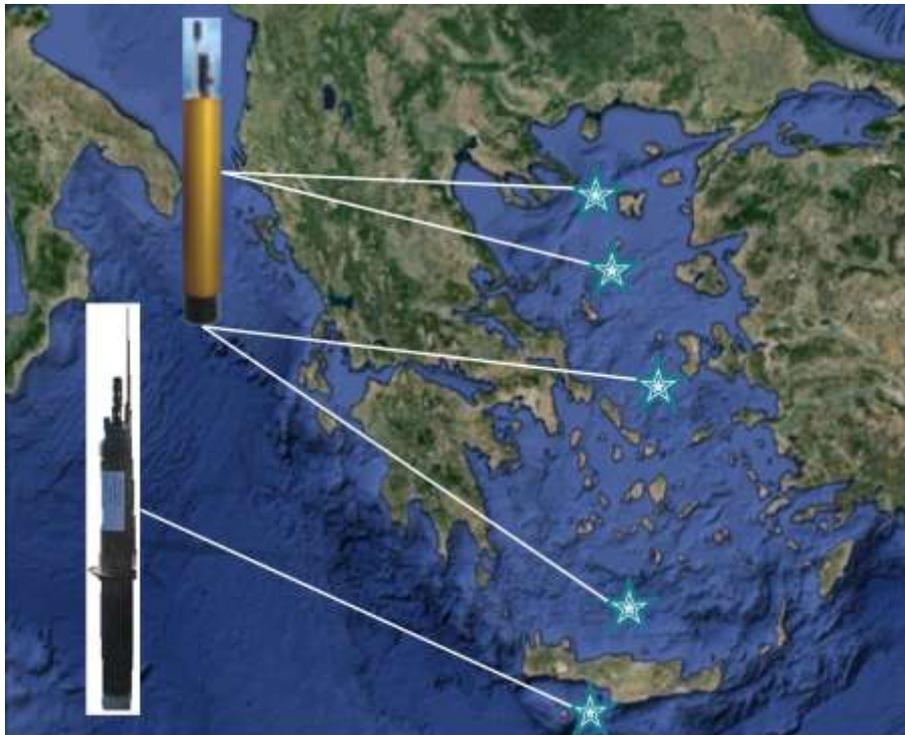


Figure 1. Greek Argo deployments sites during 2015.

All floats have been integrated in the MedArgo project. Taking into account the proposed sampling strategy for the Mediterranean Sea and the bathymetry of the deployment site and the adjacent areas, the mission parameters of the floats were set as follows: The parking depth of the floats was set to 350m, its profiling depth to 1000m and the cycle period to 5 days. The raw data of the Greek float are delivered at the Coriolis data Centre where the real time quality control takes place while the delayed mode quality control of the data will be processed by the MedArgo Centre at OGS.

1.2 Float Development

In 2013, HCMR has constructed an Argo float's detection system after the process of locating a float has been described and the various approaches have been indicated. A prototype active locator unit has been developed, and the principle of operation has been demonstrated. The unit has been tested successfully on land and at sea at the SIDERI workshop at 17-18 September 2013 that took place at Heraklion, Greece. The deck unit communicates via bluetooth with any mobile phone which is used for interface and control. Future work includes the study of a pressure housing and antenna design. This activity was under the task of proposing and testing simple methods of tracking and recovery Argo floats in short time and range scales in the framework of SIDERI FP7 project.

1.3 Data management

HCMR has run an extended network of buoys within the Aegean and Ionian Seas including the multi-parametric M3A observatory of the Cretan Sea and a deep sea (2000m) bottom platform deployed in the Ionian Sea (POSEIDON & POSEIDON-II monitoring, forecasting and information systems). HCMR also operates the Hellenic National Oceanographic Data Centre (HNODC) established in 1986, as part of the National Centre for Marine Research (NCMR). HNODC operates as a National Agency and is responsible for processing, archiving and distributing marine data. HNODC is also developing techniques for oceanographic data processing and data base maintenance. Furthermore it promotes the International Exchange of Data in the frame of its cooperation with the "Intergovernmental Oceanographic Commission IOC) of UNESCO as it is responsible for the coordination of International Data Exchange (IODE) in Greece. The HNODC manages a variety of oceanographic data and information collected by several Hellenic Marine Research Laboratories and in particular from the Institute of Oceanography of the Hellenic Centre for Marine Research-HCMR as well as from HNODC's participation in international projects (MTP-II MATER, MEDAR/MEDATLAS II, HUMBOLDT, SEADATANET). Moreover within the My Ocean project (GMES MCS) HCMR will consolidate and improve its in-situ data services for the Eastern Mediterranean region building on the capacity developed under POSEIDON, MFSTEP (coordination of M3A time-series network, analysis and provision of basin scale data), and MERSEA projects (coordination of Mediterranean in situ observations).

Delayed-mode data processing. HCMR has not developed yet a delayed-mode quality control capability for the Greek Argo data. The delayed mode quality control of the data delivered from the Greek Argo float will be processed by the MedArgo data centre. HCMR considers the possibility of developing delayed-mode data processing for ARGO profiles collected within the Eastern Mediterranean region. HCMR may also contribute to the improvement of the delayed mode quality control processing conceding CTD data collected through several HCMR research cruises. HCMR operates the Med Sea data portal that was set up for the needs of MyOcean project. Within this framework HCMR is in charge of validating biochemical data from Argo floats that are operating in the Mediterranean.

1.4. Operational and scientific use of Argo data

A very important activity, in the frame of the Greek Euro-Argo programme (which will demonstrate the Argo value) is the development of the capabilities in order to exploit Argo data for operational forecasting as well as for research applications. Along this direction, HCMR established a network of relevant Greek scientific groups mainly from Universities and Research Institutes which constitute the Greek Argo Users group/network. These different groups are already using or will be using ARGO data in ocean/atmospheric forecasting, climate studies and for educational purposes. On January 2014 the first Greek Argo Users meeting was hosted by HCMR aiming to present the activities of the national network to coordinate present and future actions that will take place at national level. The 2nd meeting of the members of the Greek Argo infrastructure was held on January 2015. The 3rd meeting took place on December 2015 and there were 5 scientists participating from HCMR Institute of Oceanography and 7 scientists and researchers from different Universities and departments from all over Greece. It is expected that the Greek Argo Users Group will further grow and expand its activities concerning the scientific exploitation of Argo data and the

cooperation among Greek scientists. The next step will be the expansion of the Greek Argo network in more members. The network is already in contact with many organizations / agencies / institutions and it is foreseen that the establishment of the E-A ERIC will increase the interaction of the Greek Argo Users Group with the European and international ARGO scientific community in the near future.

Operational ocean forecasting:

Med-Argo data have been already used as independent data in order to assess the impact of remote sensed and Ferrybox SSS data assimilation into the Aegean Sea hydrodynamical model component of the POSEIDON system running operationally at HCMR within the framework of POSEIDON system.

Med-Argo data are routinely assimilated (using localized Singular Evolutive Extended Kalman filtering techniques) on a weekly basis in three different modelling forecasting components (Mediterranean 1/10° resolution, Aegean Sea 1/130° resolution and Ionian – Adriatic Sea at 1/50° resolution) of the POSEIDON operational system.

Some of the results of the works described above are included in the following scientific publications:

Korres, G., K. Nittis, I. Hoteit, and G. Triantafyllou, 2009: **A high resolution data assimilation system for the Aegean Sea hydrodynamics**. *Journal of Marine Systems*, **77**, 325-340.

Korres, G., K. Nittis, L. Perivoliotis, K. Tsiaras, A. Papadopoulos, I. Hoteit and G. Triantafyllou, 2010. **Forecasting the Aegean Sea hydrodynamics within the POSEIDON-II operational system**. *Journal of Operational Oceanography*, Vol. 3, nu. 1, 37-49,

Korres, G., K. Nittis, L. Perivoliotis, G. Triantafyllou and M. Chatzinaki, 2009. **The Aegean Sea –Poseidon model**. Hellenic Centre For Marine Research, Greece.

Korres, G., M. Ntoumas, M. Potiris and G. Petihakis, 2014. **Assimilating Ferry Box data into the Aegean Sea model**. *Journal of Marine Systems*, 140 (2014) 59–72

Ocean science

Med-Argo data are currently used by a small group of researchers in Greece for studies of water mass characteristics of the different deep basins of the Mediterranean Sea and as a continuous record of T/S characteristics providing insight in the seasonal and inter-annual variability of the Mediterranean Sea and its sub-basins. A number of publications and scientific results have been released regarding the Greek Argo acquired data during the last 3 years.

Publications in scientific journals and conferences proceedings:

[1] Kassis, D., Korres, G., Petihakis, G., Perivoliotis, L., 2015. : **Hydrodynamic variability of the Cretan Sea derived from Argo float profiles and multi-parametric buoy measurements during 2010–2012**. [Ocean Dynamics, 15-00058](#). DOI: 10.1007/s10236-015-0892-0

- [2] Kassis, D., Konstantinidou, A., Perivoliotis, L., Korres, G., 2015: **Inter-comparing numerical model simulations in the Ionian Sea with Argo T/S profiles for the period 2008-2012**. In proceedings of the 11th Panhellenic Symposium on Oceanography and Fisheries, p.945-948, ISBN 978-960-9798-08-2
- [3] Kassis D., Perivoliotis L. & G. Korres, 2014: **Greek Argo: Towards monitoring the Eastern Mediterranean - First deployments preliminary results and future planning**. In proceedings of the 7th International Conference on EuroGOOS, Lisbon – Portugal, 28-30 October 2014

Scientific Sheets in Greek Argo web page:

- [1] **"Use of Lagrangian methods in optimizing Argo float deployment locations in the Mediterranean Sea"** Summary of the scientific report of the University of Aegean in the framework of the Greek Argo Project.
- [2] **"The integration of Argo floats in numerical weather prediction"** Summary of the scientific report of the Harokopio University in the framework of the Greek Argo Project.
- [3] **"Use of Argo data in ocean numerical simulations"** Summary of the scientific report of the Aristotle University of Thessaloniki in the framework of the Greek Argo Project.
- [4] **"Evaluation of climate and biochemical models using Argo data"** Summary of the scientific report of the University of Crete in the framework of the Greek Argo Project.

Scientific Sheets in Euro-Argo web page:

- [1] Kassis D., Konstantinidou A., Perivoliotis L. and Korres G., 2014: **Comparison of Argo profiles observations against numerical model simulations in Ionian Sea**. Euro Argo RI web page <http://www.euro-argo.eu/Main-Achievements/European-Contributions/Science/Regional-Seas/Med-Black-Seas/>
- [2] Kassis D. and Korres G., 2014: **Hydrological variability derived from the first Argo mission in the Cretan Sea basin**. Euro Argo RI web page <http://www.euro-argo.eu/Main-Achievements/European-Contributions/Science/Regional-Seas/Med-Black-Seas/>

Presentations in the EURO ARGO users meeting:

- [1] Kassis D., Von Schuckmann K., Korres G., 2013: **Hydrographic properties of Cretan Sea derived from Argo float's profiles and buoy data measurements during 2010-2012**. In proceedings of the 4th Euro-Argo Science Meeting and Workshop, June 2013, Southampton, UK <http://www.euro-argo.eu/News-Meetings/Meetings/Users-Meetings/4th-Users-meeting-June-2013>
- [2] Kassis, D., Perivoliotis, L., Korres, G., 2015: **Hydrological variability of the Eastern Ionian and Adriatic Seas derived from two new Argo missions in 2014**. In proceedings of the 5th Euro-Argo User Workshop - Brest, March 16-17 2015 <http://www.euro-argo.eu/News-Meetings/Meetings/Users-Meetings/5th-User-Workshop-March-2015/Workshop-Programme>

Additionally, Argo data are used for educational purposes in some Greek University Departments. Due to HCMR initiatives within Euro Argo, Greek Argo and SIDERI programmes to contact potentially interested Greek and other scientists from the eastern Mediterranean region and inform them about the benefits of Argo programme. An increasing demand for Argo data along the Aegean and Ionian Sea for both scientific and educational purposes has been registered.

2. Funding

2.1 Existing funding for Greek Argo

The procurement, deployment and operation costs of the first Greek float launched in 2010/2011 were covered by HCMR internal funds. During 2012, Greece established national funding to the Greek Argo programme through the General Secretariat of Research and Technology (GSRT), Ministry of Education, Lifelong Learning and Religious Affairs (funding agency). A major achievement is that Greece participates to the European infrastructure E-A ERIC as a full member. A tender regarding the procurement of 25 new floats during the next 3 years period has been accomplished. During 2014 the first 13 floats have been delivered while the remaining 12 have been delivered during 2015.

2.2 On the future funding, organization and planning for Greek Argo

As part of the Euro-Argo, HCMR has undertaken all necessary efforts and managed to establish long term national funding for the E-A ERIC infrastructure and to meet the standards of a full member.

Greece has deployment capabilities for the Aegean, the Ionian Sea and the central Levantine basin. Float deployments in 2016 will be performed according to the plans of the Greek-Argo research infrastructure. The main goal within 2016 is to continue the development of the Greek-Argo infrastructure array in accordance with MEDARGO and the EuroArgo infrastructure. Future deployments are a function of the operational needs of the Greek Argo network and the current coverage of areas of interest. Although the final decisions for the areas that floats will be deployed may change, the plan for 2016 generally includes:

- 2 float deployments in the Southern Aegean (where Myrtoan and Cretan Sea meet)- one of which will concern a DOVA Argo float (equipped with dissolved oxygen sensor)
- 1 float deployment in the Northern Aegean
- 1 float deployment in the Ionian Sea, since the Argo coverage in the area is good

For the Levantine Sea, although the coverage is satisfactory, the Greek Argo could contribute with 1 deployment per year, to maintain this coverage at high levels.

3. Dissemination activities of the Greek Argo– links with Euro Argo infrastructure

By the end of 2013 Greek Argo has launched its web page: www.greekargo.gr that demonstrates and promotes Greek-Argo and Euro-Argo activities. At the end of 2014 Greek-Argo web portal was upgraded providing information and data access from all floats operating in the Mediterranean and presenting all Greek Argo activities, news and data from Greek Argo floats. A further upgrade took place during January 2016, integrating more images and videos from Greek Argo deployment activities. Furthermore, new education material has been released and a school visit programme has been established.

The Euro-Argo infrastructure is also demonstrated on the POSEIDON updated web page, http://www.poseidon.hcmr.gr/article_view.php?id=57&cid=28&bc=28. The POSEIDON system is the operational monitoring and forecasting system for the Greek Seas and many of its forecasting components use T/S Argo profiles for data assimilation purposes. The POSEIDON web page is also hosting the links to the EuroArgo educational web site as well

as to the floats from each European country. The above links along with other informative material (Euro Argo leaflet, focused questionnaire) were forwarded directly to all active and potential users of Argo data in Greece. Many research groups filled and sent back the questionnaire providing valuable feedback to HCMR team. Furthermore, the EuroArgo poster and leaflet translated in Greek and they are hosted in the POSEIDON website. A press release was sent after the deployment of the Greek float. The press release is permanently hosted in the HCMR's Greek webpage, http://www.hcmr.gr/listview4_el.php?id=1110.