GREEK ARGO PROGRAMME

PRESENT STATUS AND FUTURE PLANS

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1. Background and organization of GREEK ARGO activities

Greece established 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 2018, 5 Argo floats were successfully deployed in the Greek Seas under the framework of the Greek-Argo RI activities and the MOCCA project. Four (4) of the floats were NOVA-DOVA type and were purchased by the Greek Argo RI whilst, one (1) Arvor type float was deployed under the framework of MOCCA project. The floats were deployed by the Greek-Argo team in the North, Central and South Aegean basin and in the South Ionian Sea. All floats integrate Iridium satellite telemetry system which provides a dual telecommunication capability allowing modification of the configuration in real-time. The ARVOR 3901957 float was sent to the Greek Argo Infrastructure by the Euro-Argo ERIC. It was deployed on May the 20th along with the EMSO-HELLENIC SITE multi-parametric sea-bed platform at 1520 m depth in the South Ionian area, and has been an important step in promoting collaboration between the European Research Infrastructures of Euro-Argo and EMSO ERIC. The float is a standard T / S float purchased by Euro-Argo under the framework of MOCCA project and was configured to record the profile of the water column at a depth of 1600 meters and drift to a depth of 1000 meters for the first 5 days cycle before returning to the standard Argo settings. The active floats and new deployments during 2018 are presented in Table 1:

Table 1. Active floats and new deployments performed from Greek Argo team during 2018

A/A	Float Type	WMO	IMEI NUMBER	SERIAL NUMBER	Deployment date	Deployment time	Latitude	Longitude	Available profiles	Status
1	NOVA	6901885	300234061647120	134	8/10/2014	20:00	35.79	25.12	299	Active
2	NOVA	6903276	300234063609400	271	13/7/2016	8:00	35.09	25.05	180	Active
3	ARVOR	3901890	300234063609200		4/4/2017	1:15	39,16	24,93	125	Active
5	ARVOR	3901957	300234064702860		20/5/2018	09:15	36,84	21,60	55	Active
6	NOVA	6903281	300234061645120	132	23/5/2018	00:30	36,01	23,75	32	Inactive
7	NOVA	6903282	300234061661440	139	23/5/2018	17:15	36,92	23,55	44	Active
8	DOVA	6903283	300234062954200	245	17/6/2018	16:00	39,76	24,36	39	Active
9	NOVA	6903284	300234062956200	235	19/06/2018	21:00	38,41	25,43	40	Inactive

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 350 m, its profiling depth to 1000 m 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. The 3901890 Arvor float is configured to alternate its profile depth between 700 and 1000 m and the 3901957 Arvor float is configured to alternate its profile depth between 1600 and 1000 m.

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 in 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 (2000 m) 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 Copernicus CMEMS services. 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, under the framework of the Greek-Argo activities is the exploitation of 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. 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 Ferry-box SSS data assimilation into the Aegean Sea hydrodynamic 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 $1/10^o$ resolution, Aegean Sea $1/130^o$ resolution and Ionian – Adriatic Sea at $1/50^o$ 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 4 years.

Publications in scientific journals and conferences proceedings:

Kassis, D., Korres, G., Konstantinidou, A., Perivoliotis, L., 2017. Comparison of high-resolution hydrodynamic model outputs with in situ Argo profiles in the Ionian Sea. Mediterranean Marine Science, 0, 22-37. doi:10.12681/mms.1753

Kassis, D., Korres, G., Perivoliotis, L., 2016. Sub-mesoscale features of the Eastern Ionian Sea as derived from Argo floats operating during 2014-2015, in: Submesoscale Processes: Mechanisms, Implications and New Frontiers. Presented at the 48th Liege Colloquium, University of Liege, Liege, Belgium.

Kassis, D., Krasakopoulou, E., Korres, G., Petihakis, G., Triantafyllou, G.S., 2016. Hydrodynamic features of the South Aegean Sea as derived from Argo T/S and dissolved oxygen profiles in the area. Ocean Dyn. 1–18. doi:10.1007/s10236-016-0987-2

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

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

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

Doctorate theses:

Kassis, D., 2017: Operational in - situ monitoring of the Greek seas as a tool to describe hydrodynamic variability and its effect on the biochemical distribution, National Technical University of Athens (NTUA),
https://www.didaktorika.gr/eadd/handle/10442/40700?locale=en

Scientific Sheets in Greek Argo web page:

"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.

"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.

"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.

"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:

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/

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:

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

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. Furthermore, a presentation of Greek Argo and Euro-Argo activities was made at the University of Aegean (Marine Sciences department) in November 2016.

2. Funding

2.1 Existing funding for Greek Argo

Currently there is no existing funding for the 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.

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. Regarding the Greek Argo RI annual contribution to Euro-Argo RI an indicative estimation is the following:

Personnel committed/dedicated to Euro-Argo activities (man months/year):

- National representation, member commitments: 2.5
- Float preparation, deployment, procurement: 1

Personnel committed/dedicated to Greek-Argo activities (man months/year):

- Greek Argo coordination and management: 3
- Float preparation, deployment, procurement, fleet operation and data monitoring: 4.5

Greece has deployment capabilities for the Aegean, the Ionian Sea and the central Levantine basin. Float deployments in 2019 will be performed according to the plans of the Greek-Argo research infrastructure. The main goal within 2019 is to continue the development of the Greek-Argo infrastructure array in accordance with the Euro-Argo 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 2019 generally includes:

- 1 float deployment in the South Aegean (where Myrtoan and Cretan Sea meet)-one of which will concern a DOVA Argo float (equipped with dissolved oxygen sensor)
- 1-2 float deployments in the North Aegean
- 1 float deployment in the Ionian Sea

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

Within 2018 several dissemination activities were carried out by the Greek Argo RI such as the participation of Greek Argo in the 2018 Researchers Night and the educational activities for high school students throughout the year. In 2017, under the framework of the 1st Ocean Observers Meeting (June 2017) Greek Argo presented its educational and outreach activities whilst, during the 6th Euro-Argo Users Workshop (July 2017) the Greek Argo Infrastructure activities and achievements were presented.

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 continuous upgrade is ongoing 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 since 2015.

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.