UK ARGO PROGRAMME

REPORT FOR 21ST ARGO STEERING TEAM MEETING APRIL 2020

1. Status of Implementation

Floats deployed and their performance

During the last year (2019) 14 floats were deployed. These were all core floats (temperature and salinity only). They were deployed in the North and South Atlantic and south-west Indian oceans. Two of these floats failed soon after deployment: an older APF9a float deployed in the SW Indian Ocean (SN 3902), and an APF11a float at 40S in the Atlantic (SN 8578 – sending positions but no data profiles). The number of deployments was less than planned as we were impacted quite badly by the Seabird CTD recall, with 26 APEX floats having to be returned, hence some of these missed their planned deployments due to the recalibration turnaround time with SeaBird and Teledyne Webb Research (TWR).

As at the time of writing the UK has 153 operational floats (i.e. for which real-time data are presently being distributed), as shown in Figure 1.

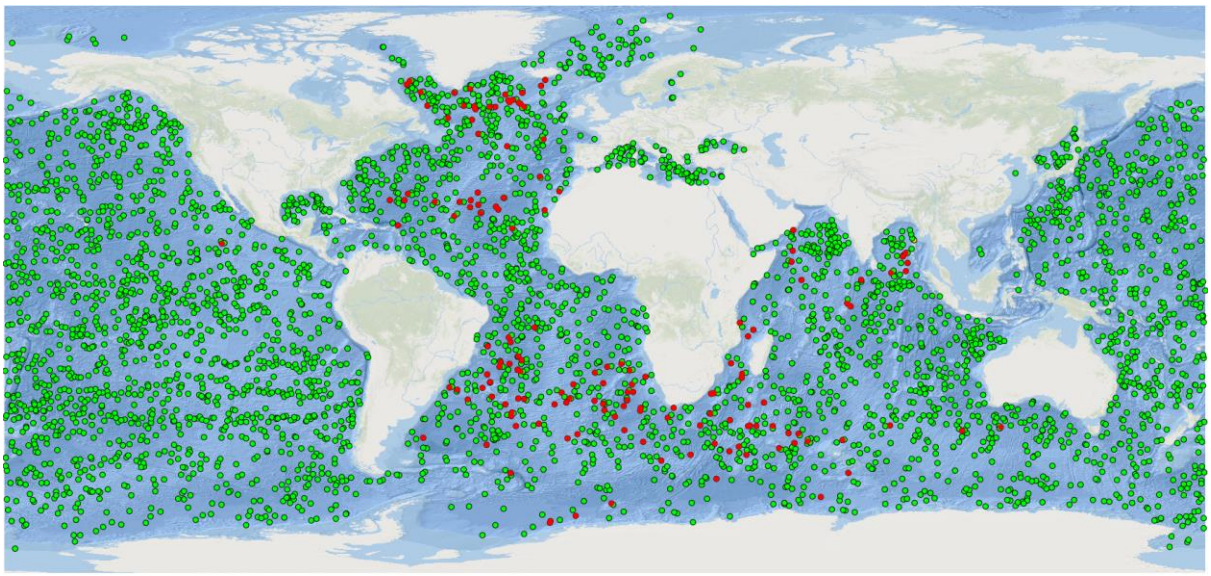

Figure 1. Showing the locations of reporting UK floats (in red, 153) with the global network (in green, 4056), as at 20th February 2020.

Technical problems encountered and solved

Bio-geochemical Argo

One of the two Navis BGCi floats deployed in December 2018 has exhibited problems (unable to go into continuous profiling mode due to the SBE41 being unresponsive), the other has failed to report after going under winter ice. A third float from that batch failed pre-deployment testing and was sent back to SeaBird for repair and a firmware upgrade and has subsequently been returned. Two other Navis BGCi floats purchased in 2019 have also been returned to SeaBird for the firmware upgrade.

APEX Deep activity since March 2019

The UK has one working APEX Deep float (without oxygen) at 26N in the Atlantic, deployed Nov 2018, which has presently completed 150 x 3-day cycles to 5,400m.

The UK deployed five APEX Deep floats, (four with Oxygen, one without O2) at 26N in the Atlantic in Jan/Feb 2020. Of these, three are working normally (2 with oxygen, 1 without) on 10-day cycles, cycling to the seabed (or 6,000 metres, whichever is shallower), with a grounding chain, and two have problems.

On the Jan/Feb 2020 A05 GO-SHIP cruise, the UK deployed 4 x RBR 6,000m deep CTDs on 135 full-depth (up to 6,000 metres) CTD stations in collaboration with RBR to help characterise the pressure response of the RBR Conductivity cell, working towards deploying RBR CTDs on Deep floats.

The UK expects to take delivery of 5 APEX Deep warranty replacement floats later in 2020 and has funding to procure one Deep SOLO float to develop UK capability with that technology.

APEX floats with RBR CTD

Six of these were procured in 2015. Two were planned to be deployed during the BoBBLE (Bay of Bengal Boundary Layer Experiment) cruise in June 2016. The first failed immediately after deployment so the second was returned to India for a firmware upgrade. This was done under TWR supervision and subsequently deployed in February 2017, but still failed in spite of passing all pre-deployment checks. Two other RBR CTD floats were deployed in the North Atlantic in June 2016 and both are transmitting data. The other two RBR-CTD floats were returned to TWR for upgrade/repair – one of which was deployed in the North Atlantic in October 2017 and failed, the other failed pre-deployment tests and is still with TWR for repair/upgrade.

Status of contributions to Argo data management

Real-time data processing

At present the British Oceanographic Data Centre (BODC) are processing data from 153 operational UK floats, 13 Irish floats and 71 Euro-Argo MOCCA floats (during 2018, 74 MOCCA floats were being processed, but three have since failed). From 5th June 2018, all BUFR messages distributed on the WMO Global Telecommunications System (GTS) have been generated by the Met Office from the real-time NetCDF files produced by BODC, for all the floats listed above. In 2020 it is planned to include the capability to include supplementary profiles and oxygen into the BUFR files generated by the Met Office.

However, at present there remains a significant number of APF11i floats deployed over the last five years for which the data are not yet being processed, 17 active at the end of 2019 plus a number that have failed, these are all listed below.

Deployed in 2015
2 APEX Deep (both failed)

Deployed in 2016
2 Arvor Deep (both failed)
3 APEX RBR (1 failed on deployment, 2 are operational)
3 APEX Deep (all subsequently recovered)

Deployed in 2017
2 APEX RBR (both failed)
6 APEX with O2 & pH
4 APEX Deep with O2 (2 have failed)

Deployed in 2018
2 APEX with O2
4 APEX Deep

Deployed in 2019
1 core APEX

Deployed in 2020
4 APEX Deep with O2
1 APEX Deep
2 core APEX with ice avoidance

The current priority is to implement APF11i processing which will be needed for all our newer APEX core floats, as well as for the APEX Deep and oxygen/pH floats. The focus will be on ensuring that the real-time data (even if only temperature and salinity) are processed and delivered to the GTS and GDACs from all the above float types. The work for delivering the APF11i float data is advancing well.

Delayed-mode QC processing

The BODC DAC hosts 95,064 profiles as of 3rd April 2020, of which 55,294 profiles are now in delayed-mode. This represents 58% of all profiles, or approximately 64% of eligible profiles (i.e. all profiles from expired floats and profiles over one-year old from active floats). This is a significant improvement on past years, with around 16,750 profiles having been through delayed-mode QC performed by BODC in the past year, plus DMQC submitted by partners on floats from the MOCCA project. BODC has been tracking floats affected by the high salinity drift issue and will feed-in to this monitoring and analysis.

BODC undertook a survey of core DMQC operators and issued a report to inform future development of DMQC software and practices. NOC/BODC/PML held a UK O2 and pH workshop in Southampton in December 2019 as part of our development of capability in this area, focusing on the use of SAGE developed by MBARI for A-mode adjustments.

Southern Ocean Argo Regional Centre

In the past year BODC has compiled a guide to 'Argo and the Antarctic Treaty' and begun a review of CTD on deployment metadata in support of DMQC. BODC has also worked with the University of Bristol to develop a piece of software to perform Southern Ocean zone classifications, and co-supervised a Masters student project making use of these classifications to look at Southern Ocean zone variability.

Argo and the NVS

In the past year, the policy and governance for managing the Argo reference tables on the BODC-hosted NERC Vocabulary Server (NVS) have been established, a prioritised work plan for the migration work has been developed, and this work has begun with a number of initial vocabularies either created or in-progress.

2. Funding and human resources

The UK Argo programme is undertaken by a partnership between the Met Office, the National Oceanography Centre (NOC, which includes BODC) and Plymouth Marine Laboratory (PML). The Met Office are responsible for programme management and coordination, procurement of floats, organizing float deployments, preparation of floats for deployment, telecommunications (costs) and international contributions. NOC and BODC have responsibility for Argo science and data management respectively. PML play a leading role in the recent expansion of the UK programme into BGC-Argo.

UK Argo funding to the Met Office is presently provided by BEIS (Department for Business, Energy and Industrial Strategy) mainly through the Hadley Centre Climate Change Programme (HCCCP), but with an additional contribution through the Public Weather Service Programme. The HCCCP funding is agreed for a 3-year period to end March 2021 and provides ongoing funding for around 20 core floats per year. With this Argo funding now part of the HCCCP it should be less vulnerable to being cut.

NERC funding for Argo is primarily directed through NOC under its National Capability (NC) funding line. On 1st November 2019 NOC became an independent self-governing organisation – a charitable company limited by guarantee. With this independence NOC has discretion on the allocation of NC funds from NERC, which covers Argo data management at BODC and Argo science at NOC. In addition, it is expected that up to ten floats per year for the Argo extensions (deep and bio-geochemical) could be provided through bids to NERC for funding.

Staff members working on UK Argo, their institution and an estimate of their fraction of full time equivalent time spent on Argo during FY2019/20 (April 2019 – March 2020) are listed below:

Jon Turton, Met Office (0.25) – UK Argo manager
Fiona Carse, Met Office (0.4) – UK Argo manager
John Hankins, Met Office (0.1) – float testing, set-up and shipping.
Brian King, NOCS (0.25) – Core and Deep Argo science lead [estimated on BK's behalf]
Giorgio Dall'Olmo, PML (0.1) – BGC Argo science lead
Matt Donnelly, BODC (1.0) - DAC operations, DAC development, DMQC support, Argo Vocabs support, SOARC lead
Clare Bellingham, BODC (1.0) - DAC operations, DMQC operator
Kamila Walicka (0.6) - DMQC operator and tools
Ed Small (0.6 - 1 year project) - DMQC tools
Violetta Paba, BODC (0.6) - DAC operations, BGC QC, Argo Vocabs lead
Katie Gowers, BODC (0.3) - DAC development
Paul McGarrigle, BODC (0.1) - DAC system support
Justin Buck, BODC (0.1) - Argo Vocabs support
Roseanna Wright (0.05) - SOARC task
Sarah Chapman (0.02) - SOARC task

Total: 6.57 FTE.

3. Summary of deployment and data management plans

Deployment plans

At the time of writing we have 46 core APEX floats available for deployment. We also have three Navis BGCi floats (with another two presently with Seabird for upgrading) and seven deep APEX floats in stores (with five APEX Deep warranty replacements expected later in 2020). PML also have one ProvBio float that was recovered in 2018. In addition, in April 2020, there are 23 new (Argo-equivalent) APF11i floats funded through the Royal Navy (RN).

So far in 2020, UK Argo has deployed 8 core floats and 4 deep floats, although deployments are now on hold due to the Covid-19 pandemic. Over the coming year (April 2020 to March 2021) it is hoped that UK Argo will deploy around 20 core floats (North and South Atlantic, Southern Ocean and Indian Ocean), although this will be highly dependent on the timing of easing of Covid-19 restrictions. Tentative deployment plans are:

2 - 4 APEX (2 Argos, 2 Iridium): North Atlantic, Rockall Trough/Iceland Basin (June 2020)
2 - 3 APEX (Argos): SW Indian from SA Agulhas (ACSA line, July 2020)
2 - 3 APEX (Argos): SE Atlantic from SA Agulhas (Gough line, Sept 2020)
4 APEX: Drake Passage and/or Weddell Sea (DY126 Jan/Feb 2021)
6 - 8 APEX (Argos and Iridium): North and South Atlantic, on AMT cruise (March 2021)
2 APEX (Argos): Indian Ocean, to be deployed by Mauritius Met Service (2020)

The above is not a complete list and other deployment opportunities will be investigated. If suitable opportunities become available, we may also deploy up to 7 deep floats (3 CTD only, 4 with oxygen) and up to 5 bio-geochemical floats (Navis BGCi).

The 23 RN floats (18 of which have the RBR CTD) will be deployed as 'Argo-equivalents' by the RN in the North Atlantic at locations and times of their choice, but the real-time data will not be available internationally for at least sometime after deployment. However, it is expected the data will eventually be made available to the global system in slower time.

Data management plans for the coming year

- BODC will deliver all APF11i core data before ADMT-21;
- BODC aspires to release of all BGC data by ADMT-21;
- BODC will release a Python version of the OWC DMQC software as part of the MOCCA project;
- NOC/BODC will work to further support the development of core DMQC under the Euro-Argo RISE WP2 and with NERC NC funding;
- NOC/BODC are contributing to the development of deep Argo QC, which will include a survey of the Deep Argo community on current approaches, under EuroArgo RISE WP3 and NERC NC;
- NOC/BODC will implement their first oxygen and pH calibrations under EuroArgo RISE WP4 and NERC NC;
- BODC will migrate most of the Argo reference tables onto the NVS vocabulary server as part of ENVRI-FAIR project in the coming year - this is already advancing well;
- BODC will begin work on SOARC regional data quality assessments under EuroArgo RISE WP5 in the coming year;
- BODC and the Met Officer aspire to further improve GTS timeliness and are considering ways to move towards a 3 hrs target;
- BODC will work with AOML to convene the 1st DAC Workshop during ADMT-21.

4. Uses of Argo data in the UK

Argo data are used widely within NOC, where the science applications include:

- measurement of evolution and drivers of mixed layer processes in the (Indian Ocean);
- Inventory and evolution of heat and freshwater establishing controls on budgets (both regional and global);
- deep heat content (N Atlantic).

PML have the lead for BGC Argo in the UK, where the data are used for:

- investigating different aspects of the biological carbon pump (e.g., mixed-layer pump, fragmentation);
- investigating export fluxes and efficiency in hypoxic ocean regions;
- providing a description of the physical environment in the framework of biological (e.g. mapping eel migration routes) and biogeochemical studies;
- developing techniques to generate 3D fields of biogeochemical variables by merging ocean-colour and in-situ data;
- investigating mesoscale structures by combining altimetry and in-situ profiles with a special focus on Agulhas rings.

At the Met Office Argo data are used operationally:

- they are routinely assimilated into its FOAM (Forecasting Ocean Assimilation Model) suite which is run daily and produces 2 analysis days and a 7-day forecast;
- fields from global FOAM are also used to initialise the ocean component of coupled monthly-to-seasonal forecasts;

- Argo data are also used in the initialization of ocean conditions in climate models run to make decadal predictions;
- a coupled ocean/atmosphere prediction system has been developed for weather forecasting timescales, and is now being run operationally, delivering ocean forecast information to the Copernicus Marine Environment Monitoring Service (CMEMS);
- near-surface Argo data are used to validate the output from the Met Office's OSTIA (Operational Sea Surface Temperature and Sea Ice Analysis), where the OSTIA fields are used as a lower boundary condition in numerical weather prediction models run by both the Met Office and ECMWF.

Two new Met Office systems which are in the process of being made ready for operational implementation are:

- an improved resolution version of global FOAM with 1/12 degree horizontal resolution, due for operational implementation in 2020. This will continue to make use of Argo data to constrain the T/S fields in the same way as the existing ¼ degree resolution system.
- a coupled weather forecasting system which is initialised using coupled data assimilation, due for operational implementation in 2021. Once this is implemented operationally Argo data will directly contribute to operational weather forecasts as well as ocean forecasts. An assessment of the impact of Argo in a lower atmospheric resolution version of that coupled system was detailed in King et al., 2019.

Met Office research & development applications (non-operational) which have made significant use of Argo data:

- David Ford has done some OSSEs looking at the impact of the planned BGC-Argo array of floats in a global physical-biogeochemical model where he assimilates synthetic versions of the BGC Argo profiles in conjunction with satellite ocean colour data. A paper based on that work is currently in preparation.
- one other project where we made good use of Argo data was in the assimilation of satellite sea surface salinity data from SMOS, Aquarius and SMAP. The near-surface salinity data from Argo was used to bias correct the satellite salinity data and was crucial for the performance of the assimilation of SSS data. That work is written up in Martin et al., 2019.

In the Hadley Centre for Climate Science, Argo data is used to make the following products:

- EN4 contains in-situ ocean temperature and salinity profiles and objective analyses. It is updated monthly using real-time Argo profiles and GTSPP data, and annually using delayed-mode Argo profiles (and WOD, GTSPP and ASBO data). EN4 is freely available for scientific research use (see http://www.metoffice.gov.uk/hadobs/en4/). In 2019 a user requirements survey was undertaken about EN4 and an updated version incorporating more uncertainty information and an updated analysis system is due for release this year (EN5).
- HadIOD (Hadley Centre Integrated Ocean Database) is a database of in situ surface and subsurface ocean temperature and salinity observations supplemented with additional metadata including bias corrections, uncertainties and quality flags. The dataset is global from 1850-present with monthly updates. The current version is HadIOD.1.2.0.0, the chief sources of data are ICOADS.2.5.1, EN4 and CMEMS drifting buoy data. Public release will be in mid-2020 via https://www.metoffice.gov.uk/hadobs/.

Met Office science uses of the EN4 product include OHC analysis, contributions to BAMS, Ocean Obs'19 White Paper and an upcoming Earth Energy Imbalance paper (Schuckmann et al., submitted).

References

King, R.R., D.J. Lea, M.J. Martin, I. Mirouze and J. Heming. The impact of Argo observations in a global weakly-coupled ocean-atmosphere data assimilation and short-term prediction system. Q J R Meteorol Soc. 2019; doi:10.1002/qj.3682.

Martin MJ, King RR, While J, Aguiar AB. Assimilating satellite sea-surface salinity data from SMOS, Aquarius and SMAP into a global ocean forecasting system. Q J R Meteorol Soc 2019;145:705–726. https://doi.org/10.1002/qj.3461

5. Issues from UK to be considered by AST

None.

6. Cruise CTD data

When the UK notifies float deployments with JCOMMOPS, we include any information about nearby or simultaneous CTD casts if the scientists on board the deploying ship provide this. It is written in the Description free text box in the notification form. All CTD data from UK cruises is best obtained from BODC, using the enquiries@bodc.ac.uk email contact address.

7. Bibliography for UK Argo

UK Argo PIs are Jon Turton, Fiona Carse, Brian King and Giorgio Dall'Olmo.

Included below is a list of 34 papers published during 2018 to 2020, with at least one author based at a UK institution. There are 8 papers in 2018, 25 in 2019, and 1 in 2020. The search was carried out using Web Of Science, using keyword "Argo" and refining by country (England, Scotland, Wales, Northern Ireland). PhD theses are not included in this list.

2020

Briggs, Dall'Olmo and Claustre (2020)
Major role of particle fragmentation in regulating biological sequestration of CO2 by the oceans, Science, Vol. 367, Issue 6479, pp. 791-793, DOI: 10.1126/science.aay1790

Santana, R; Costa, FB; Mignac, D; Santana, AN; Vidal, VFD; Zhu, J; Tanajura, CAS
Model sensitivity experiments on data assimilation, downscaling and tides for the representation of the Cape Sao Tome Eddies.
Ocean Dynamics, 2020, 70(1), 77-94. doi:10.1007/s10236-019-01307-w

2019

Rasse, R; Dall'Olmo, G
Do Oceanic Hypoxic Regions Act as Barriers for Sinking Particles? A Case Study in the Eastern Tropical North Atlantic
Global Biogeochemical Cycles, 2019, 33(12), 1611-1630, doi:10.1029/2019GB006305

King, RR; Lea, DJ; Martin, MJ; Mirouze, I; Heming, J
The impact of Argo observations in a global weakly coupled ocean-atmosphere data assimilation and short-range prediction system
Quarterly Journal Of The Royal Meteorological Society, 2019. doi:10.1002/qj.3682

March, D; Boehme, L; Tintore, J; Velez-Belchi, PJ; Godley, BJ
Towards the integration of animal-borne instruments into global ocean observing systems
Global Change Biology, 2019, doi:10.1111/gcb.14902

Li, Q; Reichl, BG; Fox-Kemper, B; Adcroft, AJ; Belcher, SE; Danabasoglu, G; Grant, ALM; Griffies, SM; Hallberg, R; Hara, T; Harcourt, RR; Kukulka, T; Large, WG; McWilliams, JC; Pearson, B; Sullivan, PP; Van Roekel, L; Wang, P; Zheng, ZH
Comparing Ocean Surface Boundary Vertical Mixing Schemes Including Langmuir Turbulence
Journal Of Advances In Modeling Earth Systems, 2019, 11(11), 3545-3592, doi:10.1029/2019MS001810

Cazenave, A; Hamlington, B; Horwath, M; Barletta, VR; Benveniste, J; Chambers, D; Doll, P; Hogg, AE; Legeais, JF; Merrifield, M; Meyssignac, B; Mitchum, G; Nerem, S; Pail, R; Palanisamy, H; Paul, F; von Schuckmann, K; Thompson, P
Observational Requirements for Long-Term Monitoring of the Global Mean Sea Level and Its Components Over the Altimetry Era
Frontiers In Marine Science, 2019, 6, doi:10.3389/fmars.2019.00582

Tintore, J; Pinardi, N; Alvarez-Fanjul, E; Aguiar, E; Alvarez-Berastegui, D; Bajo, M; Balbin, R; Bozzano, R; Nardelli, BB; Cardin, V; Casas, B; Charcos-Llorens, M; Chiggiato, J; Clementi, E; Coppini, G; Coppola, L; Cossarini, G; Deidun, A; Deudero, S; D'Ortenzio, F; Drago, A; Drudi, M; El Serafy, G; Escudier, R; Farcy, P; Federico, I; Fernandez, JG; Ferrarin, C; Fossi, C; Frangoulis, C; Galgani, F; Gana, S; Lafuente, JG; Sotillo, MG; Garreau, P; Gertman, I; Gomez-Pujol, L; Grandi, A; Hayes, D; Hernandez-Lasheras, J; Herut, B; Heslop, E; Hilmi, K; Juza, M; Kallos, G; Korres, G; Lecci, R; Lazzari, P; Lorente, P; Liubartseva, S; Louanchi, F; Malacic, V; Mannarini, G; March, D; Marullo, S; Mauri, E; Meszaros, L; Mourre, B; Mortier, L; Munoz-Mas, C; Novellino, A; Obaton, D; Orfila, A; Pascual, A; Pensieri, S; Gomez, BP; Rubio, SP; Perivoliotis, L; Petihakis, G; de la Villeon, LP; Pistoia, J; Poulain, PM; Pouliquen, S; Prieto, L; Raimbault, P; Reglero, P; Reyes, E; Rotllan, P; Ruiz, S; Ruiz, J; Ruiz, I; Ruiz-Orejon, LF; Salihoglu, B; Salon, S; Sammartino, S; Arcilla, AS; Sanchez-Roman, A; Sannino, G; Santoleri, R; Sarda, R; Schroeder, K; Simoncelli, S; Sofianos, S; Sylaios, G; Tanhua, T; Teruzzi, A; Testor, P; Tezcan, D; Torner, M; Trotta, F; Umgiesser, G; von Schuckmann, K; Verri, G; Vilibic, I; Yucel, M; Zavatarelli, M; Zodiatis, G
Challenges for Sustained Observing and Forecasting Systems in the Mediterranean Sea
Frontiers In Marine Science, 2019, 6, doi:10.3389/fmars.2019.00568

Bellacicco, M; Cornec, M; Organelli, E; Brewin, RJW; Neukermans, G; Volpe, G; Barbieux, M; Poteau, A; Schmechtig, C; D'Ortenzio, F; Marullo, S; Claustre, H; Pitarch, J
Global Variability of Optical Backscattering by Non-algal particles From a Biogeochemical-Argo Data Set
Geophysical Research Letters, 2019, 46(16), 9767-9776, doi:10.1029/2019GL084078

Bittig, HC; Maurer, TL; Plant, JN; Schmechtig, C; Wong, APS; Claustre, H; Trull, TW; Bhaskar, TVSU; Boss, E; DallOlmo, G; Organelli, E; Poteau, A; Johnson, KS; Hanstein, C; Leymarie, E; Le Reste, S; Riser, SC; Rupan, AR; Taillandier, V; Thierry, V; Xing, XG
A BGC-Argo Guide: Planning, Deployment, Data Handling and Usage
Frontiers In Marine Science, 2019, 6, doi:10.3389/fmars.2019.00502

Meyssignac, B; Boyer, T; Zhao, ZX; Hakuba, MZ; Landerer, FW; Stammer, D; Kohl, A; Kato, S; L'Ecuyer, T; Ablain, M; Abraham, JP; Blazquez, A; Cazenave, A; Church, JA; Cowley, R; Cheng, LJ; Domingues, CM; Giglio, D; Gouretski, V; Ishii, M; Johnson, GC; Killick, RE; Legler, D; Llovel, W; Lyman, J; Palmer, MD; Piotrowicz, S; Purkey, SG; Roemmich, D; Roca, R; Savita, A; von Schuckmann, K; Speich, S; Stephens, G; Wang, GJ; Wijffels, SE; Zilberman, N
Measuring Global Ocean Heat Content to Estimate the Earth Energy Imbalance
Frontiers In Marine Science, 2019, 6, doi:10.3389/fmars.2019.00432

O'Carroll, AG; Armstrong, EM; Beggs, HM; Bouali, M; Casey, KS; Corlett, GK; Dash, P; Donlon, CJ; Gentemann, CL; Hoyer, JL; Ignatov, A; Kabobah, K; Kachi, M; Kurihara, Y; Karagali, I; Maturi, E; Merchant, CJ; Marullo, S; Minnett, PJ; Pennybacker, M; Ramakrishnan, B; Ramsankaran, R; Santoleri, R; Sunder, S; Picart, SS; Vazquez-Cuervo, J; Wimmer, W
Observational Needs of Sea Surface Temperature
Frontiers In Marine Science, 2019, 6, doi:10.3389/fmars.2019.00420

Subramanian, AC; Balmaseda, MA; Centurioni, L; Chattopadhyay, R; Cornuelle, BD; DeMott, C; Flatau, M; Fujii, Y; Giglio, D; Gille, ST; Hamill, TM; Hendon, H; Hoteit, I; Kumar, A; Lee, JH; Lucas, AJ; Mahadevan, A; Matsueda, M; Nam, S; Paturi, S; Penny, SG; Rydbeck, A; Sun, R; Takaya, Y; Tandon, A; Todd, RE; Vitart, F; Yuan, DL; Zhang, CD
Ocean Observations to Improve Our Understanding, Modeling, and Forecasting of Subseasonal-to-Seasonal Variability
Frontiers In Marine Science, 2019, 6, doi:10.3389/fmars.2019.00427

Sloyan, BM; Wanninkhof, R; Kramp, M; Johnson, GC; Talley, LD; Tanhua, T; McDonagh, E; Cusack, C; O'Rourke, E; McGovern, E; Katsumata, K; Diggs, S; Hummon, J; Ishii, M; Azetsu-Scott, K; Boss, E; Ansorge, I; Perez, FF; Mercier, H; Williams, MJM; Anderson, L; Lee, JH; Murata, A; Kouketsu, S; Jeansson, E; Hoppema, M; Campos, E
The Global Ocean Ship-Based Hydrographic Investigations Program (GO-SHIP): A Platform for Integrated Multidisciplinary Ocean Science
Frontiers In Marine Science, 2019, 6, doi:10.3389/fmars.2019.00445

Smith, GC; Allard, R; Babin, M; Bertino, L; Chevallier, M; Corlett, G; Crout, J; Davidson, F; Delille, B; Gille, ST; Hebert, D; Hyder, P; Intrieri, J; Lagunas, J; Larnicol, G; Kaminski, T; Kater, B; Kauker, F; Marec, C; Mazloff, M; Metzger, EJ; Mordy, C; O'Carroll, A; Olsen, SM; Phelps, M; Posey, P; Prandi, P; Rehm, E; Reid, P; Rigor, I; Sandven, S; Shupe, M; Swart, S; Smedstad, OM; Solomon, A; Storto, A; Thibaut, P; Toole, J; Wood, K; Xie, JP; Yang, QH
Polar Ocean Observations: A Critical Gap in the Observing System and Its Effect on Environmental Predictions From Hours to a Season
Frontiers In Marine Science, 2019, 6, doi:10.3389/fmars.2019.00429

Roemmich, D; Alford, MH; Claustre, H; Johnson, K; King, B; Moum, J; Oke, P; Owens, WB; Pouliquen, S; Purkey, S; Scanderbeg, M; Suga, T; Wijffels, S; Zilberman, N; Bakker, D; Baringer, M; Belbeoch, M; Bittig, HC; Boss, E; Calil, P; Carse, F; Carval, T; Chai, F; Conchubhair, DO; d'Ortenzio, F; Dall'Olmo, G; Desbruyeres, D; Fennel, K; Fer, I; Ferrari, R; Forget, G; Freeland, H; Fujiki, T; Gehlen, M; Greenan, B; Hallberg, R; Hibiya, T; Hosoda, S; Jayne, S; Jochum, M; Johnson, GC; Kang, K; Kolodziejczyk, N; Kortzinger, A; Le Traon, PY; Lenn, YD; Maze, G; Mork, KA; Morris, T; Nagai, T; Nash, J; Garabato, AN; Olsen, A; Pattabhi, RR; Prakash, S; Riser, S; Schmechtig, C; Schmid, C; Shroyer, E; Sterl, A; Sutton, P; Talley, L; Tanhua, T; Thierry, V; Thomalla, S; Toole, J; Troisi, A; Trull, TW; Turton, J; Velez-Belchi, PJ; Walczowski, W; Wang, HL; Wanninkhof, R; Waterhouse, AF; Waterman, S; Watson, A; Wilson, C; Wong, APS; Xu, JP; Yasuda, I
On the Future of Argo: A Global, Full-Depth, Multi-Disciplinary Array
Frontiers In Marine Science, 2019, 6, doi:10.3389/fmars.2019.00439

Allison, LC; Roberts, CD; Palmer, MD; Hermanson, L; Killick, RE; Rayner, NA; Smith, DM; Andrews, MB
Towards quantifying uncertainty in ocean heat content changes using synthetic profiles
Environmental Research Letters, 2019, 14(8), doi:10.1088/1748-9326/ab2b0b

She, J; Piniella, AM; Benedetti-Cecchi, L; Boehme, L; Boero, F; Christensen, A; Crowe, T; Darecki, M; Nogueira, E; Gremare, A; Hernandez, F; Kouts, T; Kromkamp, J; Petihakis, G; Pinto, IS; Reissmann, JH; Tuomi, L; Zingone, A
An Integrated Approach to Coastal and Biological Observations
Frontiers In Marine Science, 2019, 6, doi:10.3389/fmars.2019.00314

Zuo, H; Balmaseda, MA; Tietsche, S; Mogensen, K; Mayer, M
The ECMWF operational ensemble reanalysis-analysis system for ocean and sea ice: a description of the system and assessment
Ocean Science, 2019, 15(3), 779-808, doi:10.5194/os-15-779-2019

Vinogradova, N; Lee, T; Boutin, J; Drushka, K; Fournier, S; Sabia, R; Stammer, D; Bayler, E; Reul, N; Gordon, A; Melnichenko, O; Li, LF; Hackert, E; Martin, M; Kolodziejczyk, N; Hasson, A; Brown, S; Misra, S; Lindstrom, E
Satellite Salinity Observing System: Recent Discoveries and the Way Forward
Frontiers In Marine Science, 2019, 6, doi:10.3389/fmars.2019.00243

Le Traon, PY; Reppucci, A; Fanjul, E; Aouf, L; Behrens, A; Belmonte, M; Bentamy, A; Bertino, L; Brando, VE; Kreiner, MB; Benkiran, M; Carval, T; Ciliberti, SA; Claustre, H; Clementi, E; Coppini, G; Cossarini, G; Alonso-Munoyerro, MA; Delamarche, A; Dibarboure, G; Dinessen, F; Drevillon, M; Drillet, Y; Faugere, Y; Fernandez, V; Fleming, A; Garcia-Hermosa, MI; Sotillo, MG; Garric, G; Gasparin, F; Giordan, C; Gehlen, M; Gregoire, ML; Guinehut, S; Hamon, M; Harris, C; Hernandez, F; Hinkler, JB; Hoyer, J; Karvonen, J; Kay, S; King, R; Lavergne, T; Lemieux-Dudon, B; Lima, L; Mao, CY; Martin, MJ; Masina, S; Melet, A; Nardelli, BB; Nolan, G; Pascual, A; Pistoia, J; Palazov, A; Piolle, JF; Pujol, MI; Pequignet, AC; Peneva, E; Gomez, BP; de la Villeon, LP; Pinardi, N; Pisano, A;

Pouliquen, S; Reid, R; Remy, E; Santoleri, R; Siddorn, J; She, J; Staneva, J; Stoffelen, A; Tonani, M; Vandenbulcke, L; Schuckmann, K; Volpe, G; Wettre, C; Zacharioudaki, A
From Observation to Information and Users: The Copernicus Marine Service Perspective
Frontiers In Marine Science, 2019, 6, doi:10.3389/fmars.2019.00234

Gasparin, F; Guinehut, S; Mao, CY; Mirouze, I; Remy, E; King, RR; Hamon, M; Reid, R; Storto, A; Le Traon, PY; Martin, MJ; Masina, S
Requirements for an Integrated in situ Atlantic Ocean Observing System From Coordinated Observing System Simulation Experiments
Frontiers In Marine Science, 2019, 6 doi:10.3389/fmars.2019.00083

Lacour, L; Briggs, N; Claustre, H; Ardyna, M; Dall'Olmo, G
The Intraseasonal Dynamics of the Mixed Layer Pump in the Subpolar North Atlantic Ocean: A Biogeochemical-Argo Float Approach
Global Biogeochemical Cycles, 2019, 33(3), 266-281,doi:10.1029/2018GB005997

Fiedler, EK; McLaren, A; Banzon, V; Brasnett, B; Ishizaki, S; Kennedy, J; Rayner, N; Roberts-Jones, J; Corlett, G; Merchant, CJ; Donlon, C
Intercomparison of long-term sea surface temperature analyses using the GHRSST Multi-Product Ensemble (GMPE) system
Remote Sensing Of Environment, 2019, 222, 18-33, doi:10.1016/j.rse.2018.12.015

Gittings, JA; Raitsos, DE; Kheireddine, M; Racault, MF; Claustre, H; Hoteit, I
Evaluating tropical phytoplankton phenology metrics using contemporary tools
Scientific Reports, 2019, 9, doi:10.1038/s41598-018-37370-4

Jones, DC; Holt, HJ; Meijers, AJS; Shuckburgh, E
Unsupervised Clustering of Southern Ocean Argo Float Temperature Profiles
Journal Of Geophysical Research-Oceans, 2019, 124(1), 390-402, DOI:10.1029/2018JC014629

Srokosz, M; Banks, C
Salinity from space
Weather, 2019, 74(1), 3-8, doi:10.1002/wea.3161

2018

Xing, XG; Briggs, N; Boss, E; Claustre, H
Improved correction for non-photochemical quenching of in situ chlorophyll fluorescence based on a synchronous irradiance profile
Optics Express, 2018, 26(19), 24734-24751, doi:10.1364/OE.26.024734

Germe, A; Sevellec, F; Mignot, J; Fedorov, A; Nguyen, S; Swingedouw, D
The impacts of oceanic deep temperature perturbations in the North Atlantic on decadal climate variability and predictability
Climate Dynamics, 2018, 51(5-6), 2341-2357, doi:10.1007/s00382-017-4016-z

Nencioli, F; Dall'Olmo, G; Quartly, GD
Agulhas Ring Transport Efficiency From Combined Satellite Altimetry and Argo Profiles
Journal Of Geophysical Research-Oceans, 2018, 123(8), 5874-5888, doi:10.1029/2018JC013909

Lange, PK; Brewin, RJW; Dall'Olmo, G; Tarran, GA; Sathyendranath, S; Zubkov, M; Bouman, HA
Scratching Beneath the Surface: A Model to Predict the Vertical Distribution of Prochlorococcus Using Remote Sensing
Remote Sensing, 2018, 10(6), doi:10.3390/rs10060847

Testor, P; Bosse, A; Houpert, L; Margirier, F; Mortier, L; Legoff, H; Dausse, D; Labaste, M; Karstensen, J; Hayes, D; Olita, A; Ribotti, A; Schroeder, K; Chiggiato, J; Onken, R; Heslop, E; Mourre, B; D'ortenzio, F; Mayot, N; Lavigne, H; de Fommervault, O; Coppola, L; Prieur, L; Taillandier, V; de Madron, XD; Bourrin, F; Many, G; Damien, P; Estournel, C; Marsaleix, P; Taupier-Letage, I; Raimbault, P; Waldman, R; Bouin, MN; Giordani, H; Caniaux, G; Somot, S; Ducrocq, V; Conan, P

Multiscale Observations of Deep Convection in the Northwestern Mediterranean Sea During Winter 2012-2013 Using Multiple Platforms
Journal Of Geophysical Research-Oceans, 2018, 123(3), 1745-1776, doi:10.1002/2016JC012671

Barbieux, M; Uitz, J; Bricaud, A; Organelli, E; Poteau, A; Schmechtig, C; Gentili, B; Obolensky, G; Leymarie, E; Penkerc'h, C; D'Ortenzio, F; Claustre, H
Assessing the Variability in the Relationship Between the Particulate Backscattering Coefficient and the Chlorophyll a Concentration From a Global Biogeochemical-Argo Database
Journal Of Geophysical Research-Oceans, 2018, 123(2), 1229-1250, doi:10.1002/2017JC013030

Mignac, D; Ferreira, D; Haines, K
South Atlantic meridional transports from NEMO-based simulations and reanalyses
Ocean Science, 2018, 14(1), 53-68, doi:10.5194/os-14-53-2018

Berry, DI; Corlett, GK; Embury, O; Merchant, CJ
Stability Assessment of the (A)ATSR Sea Surface Temperature Climate Dataset from the European Space Agency Climate Change Initiative
Remote Sensing, 2018, 10(1), doi:10.3390/rs10010126