Argo National Data Management Report

1. Real Time Status

The Japan DAC, the Japan Meteorological Agency (JMA), has processed data from 1934 Japanese Argo and Argo-equivalent floats including 119 BGC floats, 59 Deep floats and 12 RBR CTD floats, of which 172 are active floats (red dots in Fig. 1) including 4 BGC floats, 8 Deep floats and 12 RBR CTD floats, as of October 6th, 2023. There are 11 Japanese PIs who agreed to provide data to the international Argo data management. The DAC is acquiring ARGOS messages from CLS and getting IRIDIUM messages via e-mail and WebDAV server in real-time, thanks to the understanding and the cooperation of PIs. Almost all profiles from those floats are transmitted to GDACs in the netCDF format and issued to GTS using BUFR codes after real-time QC on an operational basis.

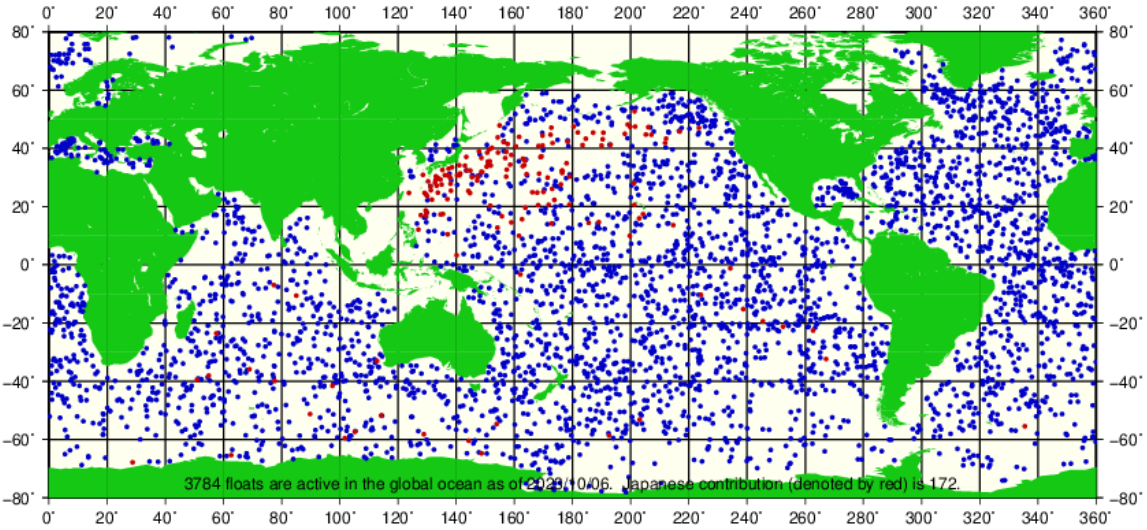

Fig. 1 Active floats (blue and red dots) on October 6th, 2023. Red dots denote floats released by Japanese PIs.

JMA and JAMSTEC have converted the meta-, prof-, tech-, and traj-files of Japanese floats, including APEX, DeepAPEX, PROVOR, ARVOR, NEMO, NOVA, Navis, NINJA, DeepNINJA and S2A. JMA and JAMSTEC have converted most all of Japanese meta-files from v2 to v3.1 and submitted them to GDAC. JMA has converted almost all of Japanese tech-files and submitted them to GDAC. Accordingly, JMA has converted the Rprof-files of Japanese ARGOS floats, except floats with NST sampling scheme and Iridium floats. JAMSTEC has converted all v2 Dprof-files of Japanese floats to v3.1 and submitted them to GDAC. JMA has converted about 68% of Japanese traj-files from v2 to v3.1 and submitted them to GDAC.
JMA has made meta-, tech-, traj-, and Rprof-files v3.1 of the almost all of floats newly deployed since March 2016 and JAMSTEC has made meta-files in v3.1 of JAMSTEC's floats newly deployed since October 2015. JAMSTEC has made Dprof-files in v3.1 since January 2016.

JMA decodes all the variables of active BGC floats of Japan. Now, JMA has been developing RTQC for each BGC parameter and implemented RTQC for DOXY and DOXY adjustments using WOA in August 2022. We plan to introduce RTQC and adjustments for other BGC parameters as well.

2. Delayed Mode QC Status

JAMSTEC has done the DMQC for all Japanese floats. JAMSTEC has submitted the delayed mode files of 208,454 profiles to GDACs as of October 6th, 2023. JAMSTEC has submitted 16,140 core delayed mode files (Core-D files) to GDACs through the Japan DAC, JMA, from November 26th, 2022, to October 6th, 2023. JAMSTEC is also re-checking the contents of the D-files and resubmitting 7,261 Core-D files during the period, based on the results of our check and the results of Dr. Annie Wong's audit of the Core-D files.
The procedure of DMQC in JAMSTEC is as follows. Our data processing system has been updated in 2022. As a result, Core-DMQC processing has become more efficient. The number of D-file submissions shows the effect.

(JAMSTEC floats and the most of Argo-equivalent floats)

5. (within 10days) data re-acquisition from CLS, bit-error repair (for ARGOS floats if possible),
   real-time processing, position QC, visual QC
2. (within 180days) surface pressure offset correction, cell TM correction
3. (after 180days) OW and WJO salinity correction, the definitive judgement by experts, D-netCDF file making

The calculation result of OW has been used at the definitive judgment. The result OW has been used just for reference.

JAMSTEC has adjusted salinity data of Deep floats by using optimal CPcor for each Deep float. When our Deep float is launched, shipboard-CTD observation is often performed. Therefore, for the optimal CPcor for each Deep float is estimated by comparing its first profile with shipboard-CTD data at its deployment. JAMSTEC will start submitting Core-D files of Deep floats whose salinity are adjusted by optimal CPcor for each Deep float by the end of 2023.

And, JAMSTEC has started performing delayed mode QC for our BGC floats. We are now preparing to processing programs for DOXY-DMQC. We are also testing whether Nitrate and pH observed by our BGC floats in the North Pacific are corrected well by SAGE. We will start to release D-mode DOXY Adjusted of our BGC floats to GDAC by the end of 2023.

3. Value Added items

・List of current national Argo web pages:

Japan Argo

https://www.jamstec.go.jp/J-ARGO/?lang=en

This site is the portal of Japan Argo program. The outline of Japanese approach on the Argo program, the list of the publication, and the link to the database site and PIs, etc. are being offered. The website restarted its service in August 2022, although it has been currently unavailable since mid-March 2021 due to a network security incident at JAMSTEC.

Real-time Database (JMA)

https://www.data.jma.go.jp/argo/data/index.html

This site shows global float coverage, global profiles based on GTS BUFR messages, and status of the Japanese floats.

・Statistics of National Argo data usage:

Operational models of JMA

MOVE/MRI.COM-G3 (Multivariate Ocean Variation Estimation System/ Meteorological Research Institute Community Ocean Model – Global version 3)

JMA operates the ocean data assimilation system for monitoring oceanic condition such as El Niño and oceanic initialization of the seasonal prediction model. The latest version (MOVE/MRI.COM-G3) had been parallelly used since February 2022 and completely replaced from the previous version (MOVE/MRI.COM-G2) in May 2023.
For details please visit:
https://www.data.jma.go.jp/tcc/tcc/products/elnino/move_mricom-g3_doc.html

JMA/MRI-CPS3 (JMA/MRI – Coupled Prediction System version 3)

JMA operates the atmosphere and ocean Coupled Prediction System (JMA/MRI-CPS3), which was replaced from the previous version (JMA/MRI-CPS2) in February 2022, as a seasonal prediction model including ENSO prediction. The oceanic model is identical to the one used for the MOVE/MRI.COM-G3.
For details please visit:
https://www.data.jma.go.jp/tcc/tcc/products/model/outline/cps3_description.html

MOVE/MRI.COM-JPN (Multivariate Ocean Variation Estimation System/ Meteorological Research Institute Community Ocean Model - an operational system for monitoring and forecasting coastal and open ocean states around Japan)

JMA operates MOVE/MRI.COM-JPN, which provides daily, 10day-mean and monthly products of subsurface temperatures and currents for the seas around Japan and North Pacific Ocean.

Other operational models

FRA-ROMSII

FRA-ROMS is the nowcast and forecast system for the Western North Pacific Ocean developed by Japan Fisheries Research and Education Agency (FRA) based on the Regional Ocean Modeling System (ROMS). FRA-ROMS was operated from May 2012 to March 2022. From March 2022, FRA began operating FRA-ROMSII, a new system based on FRA-ROMS with improved model performance in the Japan Sea. The outputs of FRA-ROMS/FRA-ROMSII are used primarily for fisheries resource surveys and are provided every week through the website: https://fra-roms.fra.go.jp/fra-roms/index.html.

・Products generated from Argo data:

Products of JMA

El Niño Monitoring and Outlook / Indian Ocean Dipole Monitoring

JMA issues on a monthly basis an ENSO diagnosis and six-month outlook as well as an IOD analysis on the following website. The outputs (ex. Fig. 2) of the MOVE/MRI.COM-G3 and the JMA/MRI-CPS3 can be found here on the Tokyo Climate Center website;.

https://www.data.jma.go.jp/tcc/tcc/products/elnino/index.html

These products serve as an indispensable basis for the operational seasonal prediction disseminated by JMA and inform National Meteorological Hydrological Services for the purpose of helping them produce their own predictions.

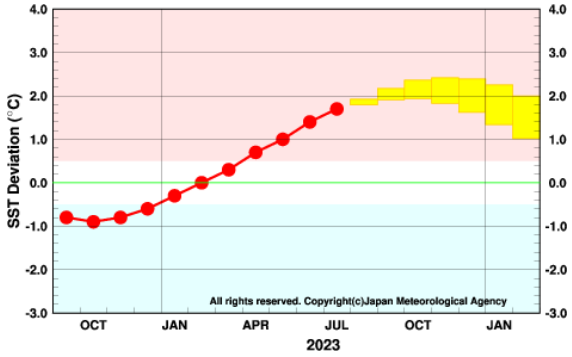

Fig. 2 Five-month running mean of the SST deviation for NINO.3 predicted by JMA's seasonal ensemble prediction system (JMA/MRI-CPS3).
Red dots indicate observed values, and yellow boxes indicate predictions. Each box denotes the range where the value will be included with the probability of 70%.

Subsurface Temperatures and Surface Currents in the seas around Japan

The following parameter outputs of MOVE/MRI.COM-JPN was released in December 2021 and can be found on https://www.data.jma.go.jp/goos/data/database.html.

- Daily, 10day-mean and Monthly mean subsurface temperatures at the depths of 50m, 100m, 200m and 400m analyzed for approximately 0.1 x 0.1 degree grid points (ex. Fig. 3).
- Daily and 10day-mean Surface Currents for approximately 0.1 x 0.1 degree grid points.

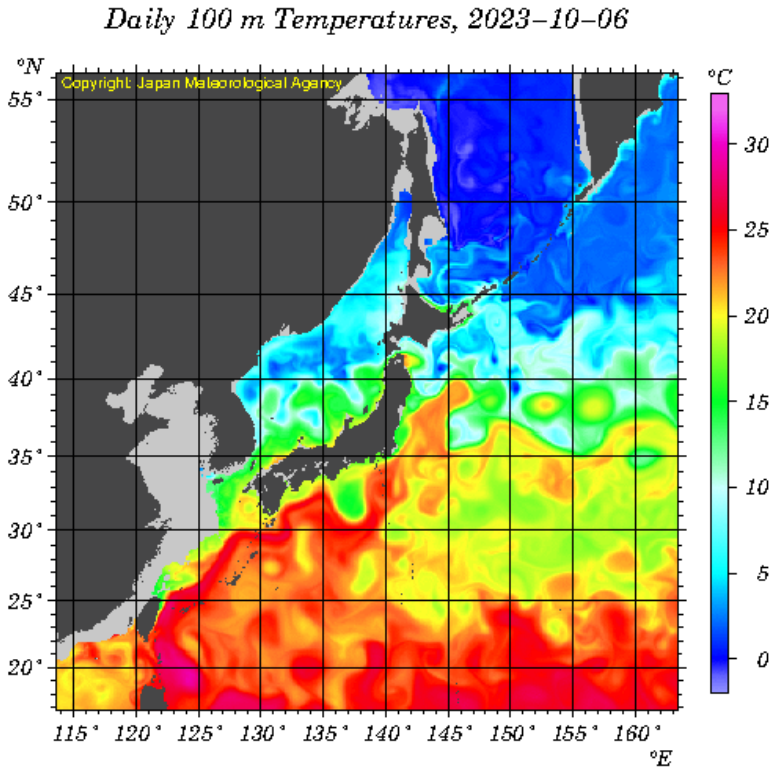

Fig. 3 Daily 100m Sea Temperature around Japan on October 6th, 2023.

Products of JAMSTEC

MOAA GPV (Grid Point Value of the Monthly Objective Analysis using the Argo data)

MOAA GPV is the global GPV data set which was made by monthly OI objective analysis using Argo and TRITON mooring data.
According to abrupt salty drift of CTD sensors on Argo floats that occur more frequently than usual because of a manufacturing problem, JAMSTEC recalculated using the Argo profile data on the latest quality control status at September 17th 2021.
Furthermore, JAMSTEC has released the new dataset mainly delayed mode Argo profile data (hereinafter referred to as Delayed Mode (DM)),

in addition to the MOAA GPV mainly using real time QC Argo profile (this version is hereinafter referred to as Near Real Time (NRT)). DM is updated once a year and JAMSTEC will recalculate the dataset for the entire period, using all Argo profile data in GDAC at that time. Therefore, DM uses more delayed mode Argo profile data than NRT.
These data set are released on the following website:
https://www.jamstec.go.jp/argo_research/dataset/moaagpv/moaa_en.html

G-YoMaHa (Objectively mapped velocity data at 1000 dbar derived from trajectories of Argo floats)

JAMSTEC mapped the drift data from Argo floats, YoMaHa'07, at the depth of 1000 dbar on a 1 degree grid, using optimal interpolation analysis. The mapped velocity field satisfies the geostrophic balance and the horizontal boundary condition of no flow through the boundary. The dataset is released on the following website:
https://www.jamstec.go.jp/argo_research/dataset/gyomaha/gyomaha_en.html

MILA GPV (Mixed Layer data set of Argo, Grid Point Value)

JAMSTEC has produced a data set of gridded mixed layer depth with its related parameters, named MILA GPV. This consists of 10-day and monthly average data and monthly climatology data in the global ocean using Argo temperature and salinity profiles.
According to abrupt salty drift of CTD sensors on Argo floats that occur more frequently than usual because of a manufacturing problem, JAMSTEC recalculated using the Argo profile data on the latest quality control status at September 17th 2021.
Furthermore, JAMSTEC has released the new dataset mainly delayed mode Argo profile data (hereinafter referred to as Delayed Mode (DM)), in addition to the MILA GPV mainly using real time QC Argo profile (this version is hereinafter referred to as Near Real Time (NRT)). DM is updated once a year and JAMSTEC will recalculate the dataset for the entire period, using all Argo profile data in GDAC at that time. Therefore, DM uses more delayed mode Argo profile data than NRT.
These data set are released on the following website:
https://www.jamstec.go.jp/argo_research/dataset/milagpv/mila_en.html

AQC Argo Data version 1.2

JAMSTEC has produced the Argo temperature and salinity profile data put through more advanced automatic checks than real-time quality controls every month. This data set has been provided in the ascii formation as well as the netcdf format, because it is useful for analyses using various software. This dataset are released on the following website:
https://www.jamstec.go.jp/argo_research/dataset/aqc/aqc_en.html

Scientifically quality-controlled profile data of Deep NINJA observations

JAMSTEC has released a product of a quality-controlled data set of Deep NINJA observations for convenient use on scientific/educational purposes. The quality-control was led by JAMSTEC on the basis of mainly comparisons with highly accurate shipboard CTD observations at float deployments. Its detailed information has been provided on the following website:
https://www.jamstec.go.jp/argo_research/dataset/deepninja/dn_en.html

ESTOC

This product is an integrated dataset of ocean observations including Argo data by using a for dimensional variational (4D-VAR) data assimilation approach. ESTOC is the open data that consists of not only physical but also biogeochemical parameters for 60 years during 1957-2016 (See the website in JAMSTEC, https://www.godac.jamstec.go.jp/estoc/e/).

JCOPE (Japan Coastal Ocean Predictability Experiment)

JCOPE is a research project for prediction of the oceanic variation using ocean models with assimilation of remote-sensing and in-situ data, which is managed by JAMSTEC. In 2019, JCOPE2M, which is updated version of JCOPE2/FRA-JCOPE2 reanalysis covering the Northwestern Pacific, was released. The Argo data are used by way of GTSPP. The hindcast data 6 months back and the forecast data 2 months ahead are disclosed on the following website: https://www.jamstec.go.jp/jcope/htdocs/e/home.html. More information is shown in
https://www.jamstec.go.jp/jcope/htdocs/e/distribution/index.html.
In 2022, JCOPE-FGO, a reanalysis product covering a quasi-global ocean, was released:
https://www.jamstec.go.jp/jcope/htdocs/e/distribution/fgo.html.

4. Regional Centre Functions

Pacific Argo Regional Center (hereafter, PARC) is now operated by JAMSTEC since 2019 when IPRC terminated to co-operate due to their funding and human resource issue. However, IPRC (APDRC) actively provides various products. Users can easily and freely download products from http://apdrc.soest.hawaii.edu/.
JAMSTEC has released the new version of PARC website in November 2022 (https://www.jamstec.go.jp/PARC). JAMSTEC is providing the float monitoring information in the Pacific region (e.g., float activity watch, QC status, anomaly from objective analysis, diagnosis plot for sensor correction, etc.), reference data set for DMQC (SeHyD and IOHB), the link to the CTD data disclosure site of Japanese PIs, some documents, and some QC tools.

JAMSTEC has also released the information of Pacific Deployment Coordination Group and its activities on the PARC website:

https://www.jamstec.go.jp/PARC/float_deployment.

This is due to the fact that the area is too large for the Pacific region to communicate with each other. You can see reports of the group meetings and members.

We also plan to develop a few new functions; to share information of technical problems and quality control of data including Core, BGC, and Deep Argo floats among PIs, and DMQC operators and users in the next year. We plan to release a part of the new functions of PARC in the next spring.

5. Other Issues

・Status of Abrupt Salty Drift for Japanese floats:

Japan has 88 floats, including BGC and Deep floats, suffering from Abrupt Salty Drift (ASD). They were deployed from 2013 to 2021. The most serial numbers of SBE41 and SBE41CP affected by ASD are 10501~11251 (Fig. 4). One of the floats are equipped with SBE41CP whose SN is larger than 11252. After last ADMT meeting, one float with SN between 8001~8500 and three floats with 11001~11251 were suffered from ASD. Six Deep floats equipped with SBE61 suffered from ASD, whose SNs are smaller than 5724.

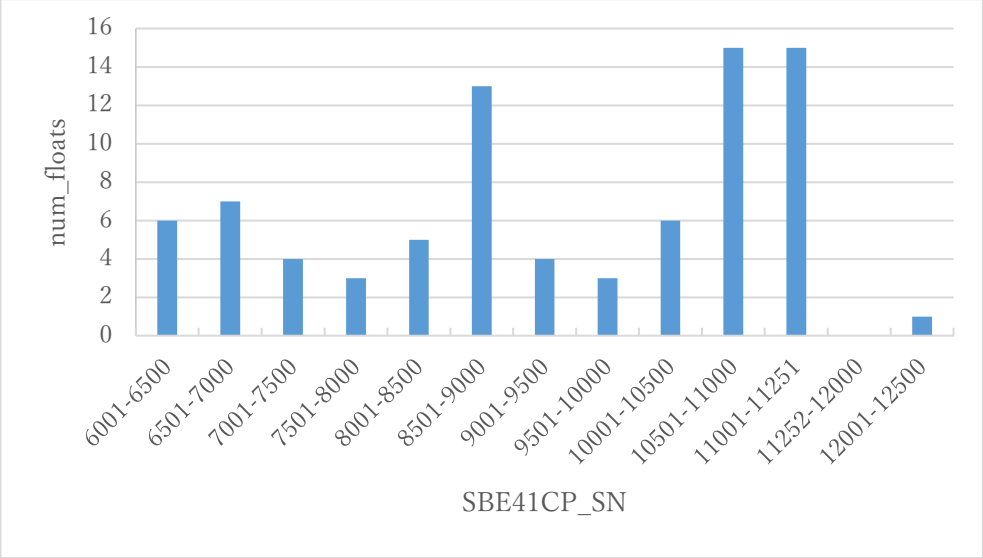

Fig. 4 Number of Japanese floats suffering from ASD by serial number range for SBE41 and SBE41CP.

Japan lost about 4,900 salinity profiles because of ASD from 2015, and they are mainly in the northwestern Pacific (Fig. 5) at a rate of about 800~900 profiles every year (Fig. 6). This number of profiles is equivalent to 5~10% of the number of profiles measured by Japanese floats (Fig. 6).

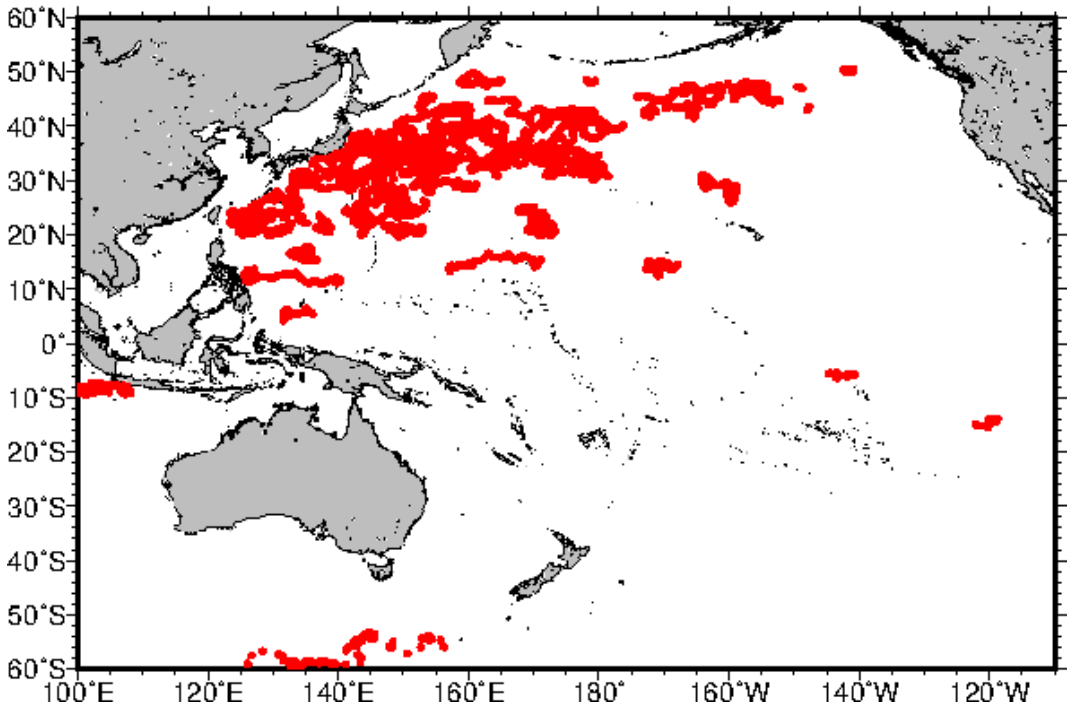

Fig. 5 Distribution of Japanese floats' PSAL profiles with PSAL_QC=4 due to ASD

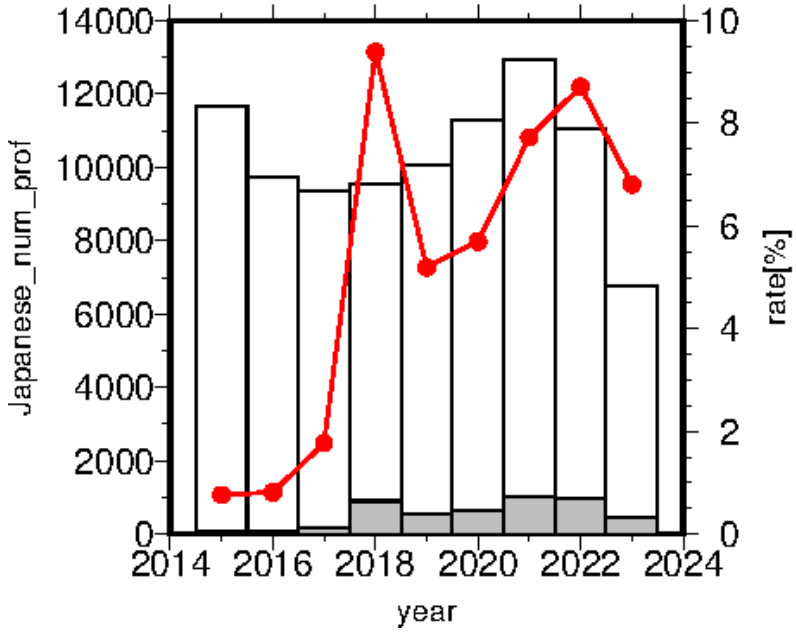

Fig. 6 (Bar) Time series of Japanese PSAL profile: (grey) those with PSAL_QC=4 due to ASD, (white) those with PSAL_QC=1,2,3,or 8. (Red line) Temporal change of the ratio of the number of Japanese PSAL profiles with PSAL_QC=4 due to ASD to the number of all Japanese PSAL profiles.

- **Development Argo real-time QC procedure using path-signature-based neural network:**

  Argo profile data undergone the real-time quality control (rQC), which are automatically processed by DACs, could contain some error data, and could sometimes be difficult to use directly for analytical researches. In this study, we propose an automated QC of Argo profiles, based on a path-signature-based neural network (NN) to improve the procedure proposed by Sugiura and Hosoda (2020). The weights of the NN were determined by learning the existing pairs of the signature of raw profile and its delayed-mode QC (dQC) flag across global Argo observation. By using the NN, nonlinear features in discriminant function for error data can be considered. Furthermore, we introduced metric learning methods for more efficient learning the QC flags. We applied the method to the global Argo profile data, and examine the advantages for the current procedures. One of the main results is that the score of precision/recall is approaching to an acceptable level of practical use, clearly improved from the previous version of the signature method. The other implication is that the precision/recall score seems to be dependent on observed area of ocean. The signature-based NN has large advantages to end-users to help providing better rQCed data by just applying a simple processing, and also opening up a possibility in offering a quick and automated QC processing of Argo profiles prior to providing dQC data.

- **Performance evaluation of oxygen sensor (ARO-FT/AROD-FT):**

  ARO-FT and AROD-FT are optical DOXY sensors, developed by JFE Advantech in collaboration with JAMSTEC in 2011. Their features are high accuracy (±2μmol/kg or ±2%) and fast response time (< 1sec). JAMSTEC have been evaluating the data quality of ARO-FT and AROD-FT (oxygen sensor for deep floats) since last two years by using the data of about 10 floats equipped with ARO-FT and about 5 floats with AROD-FT deployed after 2017. All of them were performed by multi-point calibration in the laboratory before floats deployment. Storage drift of ARO-FT and AROD-FT is more than -5 μmol/kg compared with bottle DOXY data at each float deployment. But, they can be corrected by using clear linear relationship between bottle DOXY data at each float's deployment and the difference of it and ARO-FT/AROD-FT DOXY. The fast response time of ARO-FT and AROD-FT enable us to correct their DOXY data.
  When JAMSTEC calculated carry-over coefficient and slope of each ARO-FT by using equation 21 of Bittig et al. (2018), we found that slopes are small, less than -0.016 μmol/kg/yr, although more than half of the floats had carry-over coefficient more than 0.5. When JAMSTEC compare DOXY profiles of ARO-FT adjusted by using the slopes for each sensor more than 200 days after deployment with the nearest bottle data within 25 days and 35km for them, the difference between the adjusted DOXY profile of ARO-FT and the nearest bottle data are within ±4μmol/kg at the layer deeper than 1200 dbar. Therefore, the time drift of ARO-FT is small and we can correct time drift of DOXY data of ARO-FT using by equation 21 of Bittig et al. (2018).