Argo National Data Management Report

1. Real Time Status

The Japan DAC, the Japan Meteorological Agency (JMA), has processed data from 1884 Japanese Argo and Argo-equivalent floats including 116 BGC floats, 58 Deep floats and 9 RBR CTD floats, of which 201 are active floats (red dots in Fig. 1) including 16 BGC floats, 15 Deep floats and 9 RBR CTD floats, as of November 25th, 2022. 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.

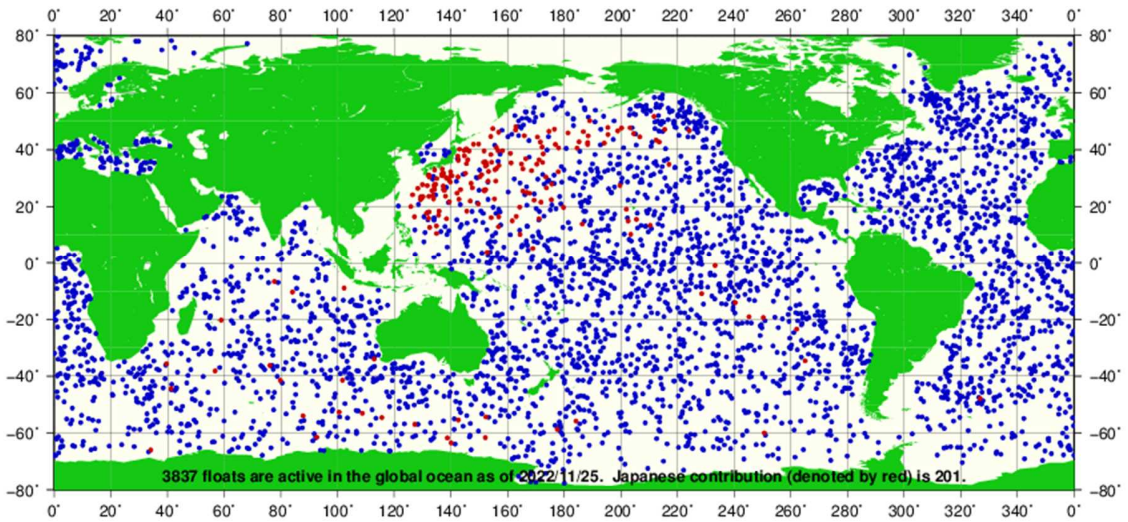

Fig. 1 Active floats (blue and red dots) on November 25th, 2022. Red dots denote floats released by Japanese PIs.

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 30% 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.

Due to a network security incident occurred at JAMSTEC in mid-March 2021, JAMSTEC's servers could not connect to the internet, and JAMSTEC was temporarily unable to send the raw data files of its Iridium communication floats to JMA. The internet connection of JAMSTEC has been completely restored, so that JAMSTEC has restarted sending the raw data files of the target floats to JMA in real time since August 2022. Therefore, JMA has recovered the Rprof-/BRprof-files and traj-files of JAMSTEC's floats within 24 hours of delivery to GDAC.

2. Delayed Mode QC Status

JAMSTEC has done the DMQC for all Japanese floats. JAMSTEC has submitted the delayed mode files of 200,085 profiles to GDACs as of November 25th, 2022.
JAMSTEC has submitted 18,517 core delayed mode files (Core-D files) to GDACs through the Japan DAC, JMA, from November 20th, 2021, to November 25th, 2022.
JAMSTEC is also re-checking the contents of the D-files and resubmitting 7,300 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.

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

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

(Argo-equivalent floats that had ceased by 2007)

JMA executes real-time processing again by using the latest procedure. The procedure after real-time processing is executed by JAMSTEC according to the procedure describe above.

The OW software is mainly operated instead of WJO. 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.

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 aim to start to release D-mode DOXY Adjusted of our BGC floats to GDAC in next spring.

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 as described in the previous subsection.

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 3)

JMA operates the Ocean Data Assimilation System for the monitoring of El Niño Southern Oscillation (ENSO) and for initialization of the seasonal prediction model. The latest version (MOVE/MRI.COM-G3) has been started since February 2022.

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 3)

JMA operates JMA/MRI-CPS3, which replaced the previous version (JMA/MRI-CGCM2) in February 2022, as a seasonal prediction model and an ENSO prediction model. The oceanic part of this model is identical to the OGCM 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 replaced the previous version (MOVE/MRI.COM-WNP) in October 2020. MOVE/MRI.COM-JPN 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.

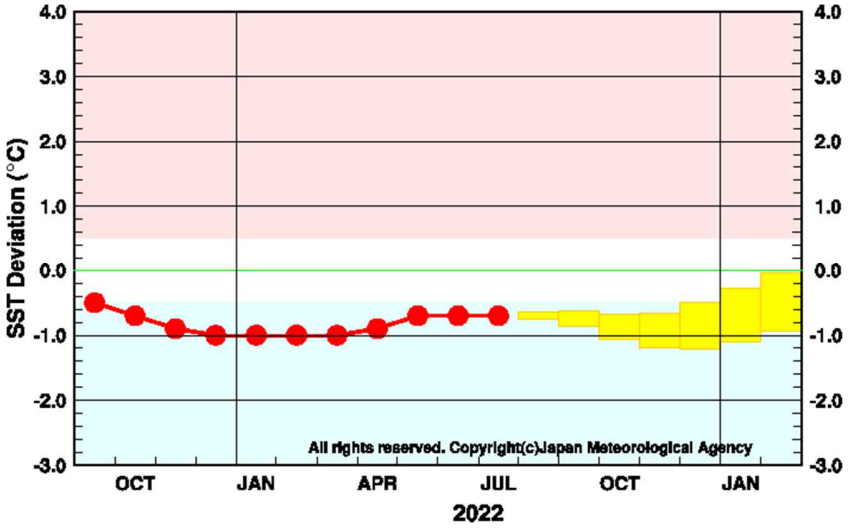

Fig. 2 Five-month running mean of the SST deviation for NINO.3 predicted by JMA's seasonal ensemble prediction system (JMA/MRI-CPS3).
Red dots indicate observed values, and yellow boxes indicate predictions. Each box denotes the range where the value will be included with the probability of 70%.

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. They replace the conventional outputs of MOVE/MRI.COM-WNP, the release of which was stopped in March 2022.

- 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.

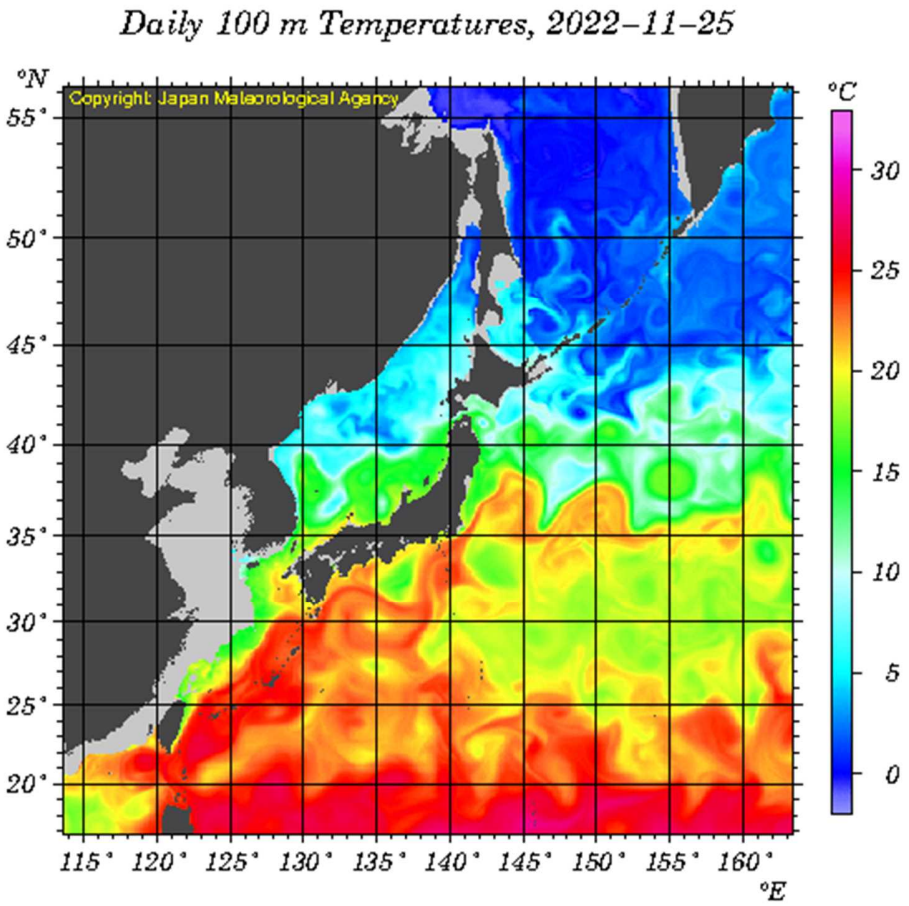

Fig. 3 Daily 100m Sea Temperature around Japan on November 25th, 2022.

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 3 months ahead are disclosed on the following website: https://www.jamstec.go.jp/jcope/htdocs/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.

- **Publicly available software tools to access or qc Argo data:**

Decoding Program Creation Support Tool (DPCST)

JAMSTEC has developed the decoding program creation support tool for APEX and Navis, by making use of our experience in creating decoding programs for various types of floats. It often happens that the data format of the same type of float is slightly different developing on the year of purchase. If you are not familiar with the data format of the float, it takes some time to find a different place between those data formats. Then, this tool can help you find differences by comparing the data formats of previously purchased same type floats with newly purchased same type floats. It outputs a list of them names in the transmission data file of the newly purchased float, with information whether or not each item name exists in the transmission data file of same type floats where were already launched. Furthermore, for the items that do not exist, this tool searches for items that are close to the item names in the transmission data file of same type floats that were already launched, by using Jaro-Winkle Distance method. Jaro-Winkler Distance method can quantify the similarity of character strings. Therefore, this tool helps DACs and PIs to find parts of our decoding program which should be modified and it contributes to shortening the time required to build a decoding program. This tool is released at GitHub: https://github.com/argojamstec/ArgofloatChecker.

4. Regional Centre Functions

JAMSTEC has operated PARC since 2019, although PARC was operated in cooperation with IPRC due to limited resources in IPRC. 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.
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 are going to share the result of deployment plan working group in Pacific on the PARC website.

5. Other Issues

- **Status of Abrupt Salty Drift for Japanese floats:**

  Japan has 83 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 10501~11000 (Fig. 4). One of the floats are equipped with SBE41CP whose SN is larger than 11252. Five Deep floats equipped with SBE61 suffered from ASD, whose SNs are smaller than 5724.

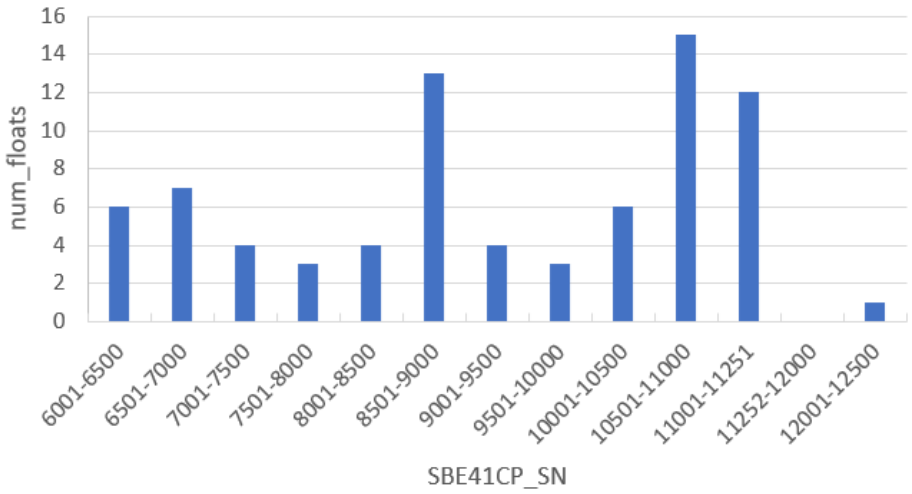

Fig. 4 Number of Japanese floats suffering from ASD by serial number range for SBE41 and SBE41CP.

Japan lost about 4,500 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).

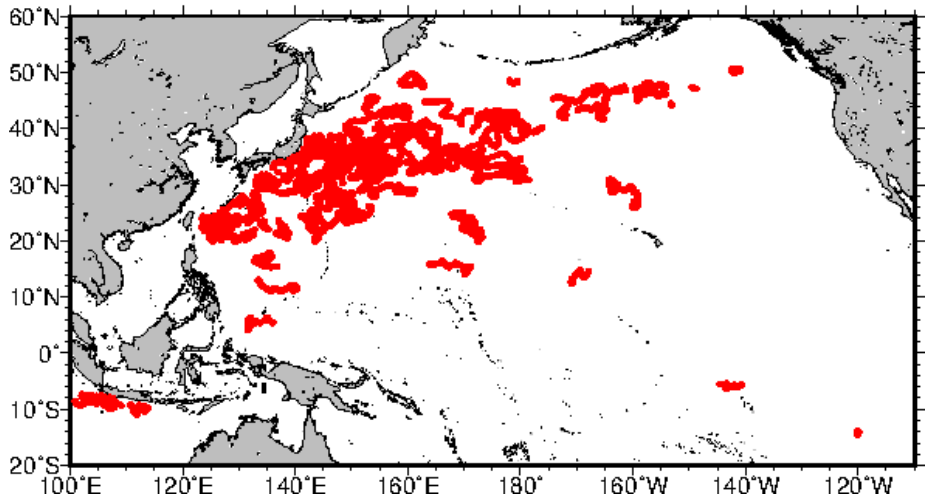

Fig. 5 Distribution of Japanese floats' PSAL profiles with PSAL_QC=4 due to ASD

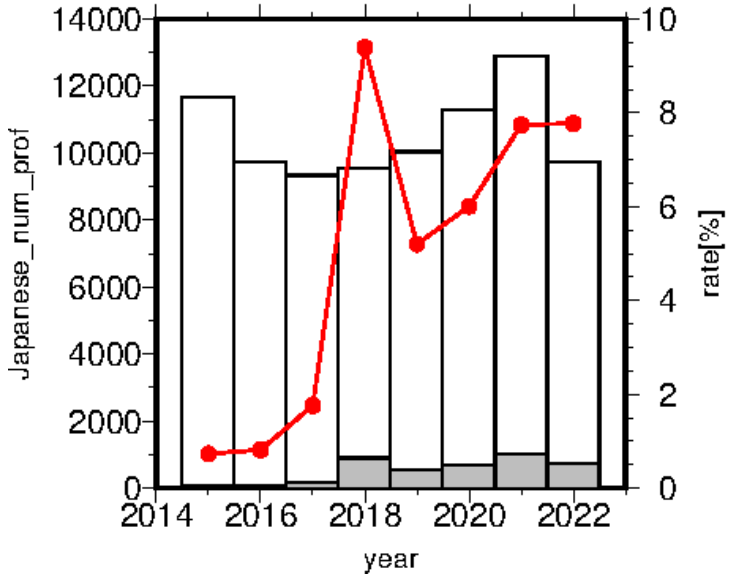

Fig. 6 (Bar) Time series of Japanese PSAL profile: (grey) those with PSAL_QC=4 due to ASD, (white) those with PSAL_QC=1,2,3,or 8. (Red line) Temporal change of the ratio of the number of Japanese PSAL profiles with PSAL_QC=4 due to ASD to the number of all Japanese PSAL profiles.

- **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.