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Intergovernmental Oceanographic Commission (of UNESCO)

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AGENDA ITEM 9: **Recommendations by the Task Teams**

AGENDA ITEM 9.5.2: **Recommendations by Task Team Buoy Data Management Centers**

SUMMARY

This document provides a report by the Task Team on Buoy Data Management Centers including actions/decisions required. Report will focus on challenges, opportunities and risks, and derived recommendations.

(Draft text for inclusion in the final report)

A. INTRODUCTION/SUMMARY[1]:

(maximum length half (1/2) a page)

In the Marine Climate Data System (MCDS) scheme, two Drifting Data Buoys Global Data Assembly Centre (DDB GDAC), have been established; lead by "Fisheries and Oceans Canada" (DFO) and Coriolis (French organization including Météo-France and Ifremer).

Both GDACs acquire data circulated on the Global Telecommunication System (GTS) of WMO. Additionally, Coriolis acquires data from Copernicus Marine. The GDACs aim is to consolidate near-real-time and delayed-mode data, to deliver a comprehensive best version archive of data and metadata.

Both GDACs routinely compare GTS bulletin headings and data volume received and have ways to make data available to requesters (DFO: through an offline form request system, France: through the Copernicus Marine Environment Monitoring Service: http://www.marineinsitu.eu/access-data/.

In addition, a public FTP server distributing data and metadata as one file per drifting buoy is operated in France: ftp://ftp.ifremer.fr/ifremer/dbcp-drifter/ (NetCDF format), and Canada distributes data grouped in monthly files on their ftp server: ftp://ftp.meds-sdmm.dfo-mpo.gc.ca/pub/dribu_bufr in CSV format.

The two DDB GDAC are working together to establish DDB GDAC organization document and user manual, to formulate exchanges and best practices between the two GDACs.

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[1] Half a page or less of Summary

B. ACTIONS/DECISIONS[2] REQUIRED:

(a) Adopt draft Action(Decision)[2] 9.5.2/1 —*Action(Decision) title;*

- Drifter DACs are to forward at regular intervals (either in near-real-time or in delayed mode) the Iridium SBD drifter messages to the Coriolis DAC.
- Participants to try out the new services provided by the GDACs and provide feedback as needed.

C. RECOMMENDATIONS[3] :

(a) Adopt draft Recommendation[3] 0.0.0/1 — *Recommendation title;*

- What, To who, Timeline
- Rational

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[2] An Action/Decision is an item directly related to DBCP and on which DBCP can action or decide directly. Details on rational for the action/decision should be included in the Background under Draft Actions/Decisions.

[3] A Recommendation involves proposed action(s)on another body outside of DBCP (e.g. SOT, JCOMM, WMO, IOC, CBS etc.). Details on rational for the Recommendation should be included in the Background under Draft Recommendation.

C. BACKGROUND INFORMATION (not to be included in the session report):

References (if any):

1. *[Link to the full report on the website]*

2. ....

Draft Actions/Decisions

- Participants to review the two GDAC documents (Drifter data management and Proposal for drifting buoy metadata in the WIGOS Metadata Standard) and send comments to the authors by 31 December 2018.

Draft Recommendations

[Comment: Details on main points and arguments leading to formulation of draft actions/decision presented in this document]

French Drifting Buoys Global Data Assembly Center report

The migration to a GDAC for Drifting Data Buoys, through the MCDS implementation phase II (2015-2017), involves Ifremer Data Center already involved in the French inter-agency program Coriolis (Ifremer leading the program, and in charge for delayed mode aspects, portal to external users, etc).

On the 2nd of May 2018, Fisheries and Oceans Canada, Ifremer were officially notified by WMO secretariat as drifting buoys GDACs within MCDS.

A daily collection and archiving of buoy reports from the global ocean is performed by Météo-France. Collaboration within the Coriolis project (www.coriolis.eu.org), with JCOMMOPS and also CLS-Argos are main aspects of this FR DDB GDAC, beside regular exchanges with other data centres, measurement teams and agencies, and with users.

Data products

Copernicus Marine service aggregates drifting buoys observations from DB-GDAC and WMO-GTS.

Drifting buoys global dataset

- INSITU_GLO_NRT_OBSERVATIONS_013_030 in situ data product
  - Real-time drifting buoys: the last 30 days of 1.636 active drifting buoys
    One NetCDF file per day and per platform
    ftp://***@nrt.cmems-du.eu/
    Core/INSITU_GLO_NRT_OBSERVATIONS_013_030/nrt/latest/*/*_TS_DB*.nc
  - History drifting buoys: all observations from 13.040 drifting buoys
    One NetCDF file per drifting buoy
    ftp://***@nrt.cmems-du.eu/
    Core/INSITU_GLO_NRT_OBSERVATIONS_013_030/nrt/history/DB/*.nc

Drifting buoys surface currents product

The surface currents product derived from drifting buoys data equipped with an anchor are produced in real-time and delayed mode by EU Copernicus Marine service.

Surface current product, real time

Since the 1st of January 2002, Coriolis (Météo-France and Ifremer) produces a **weekly surface current data** calculated from SVP drifter tracks.

This product is distributed by Copernicus Marine service as:

- INSITU_GLO_UV_NRT_OBSERVATIONS_013_048 product
  - Active buoys: ftp://*@nrt.cmems-du.eu/Core/INSITU_GLO_UV_NRT_OBSERVATIONS_013_048/drifter/latest/20190402/GL_TS_DC_*_YYYYMMDD.nc
  - History: ftp://*@nrt.cmems-du.eu/Core/INSITU_GLO_UV_NRT_OBSERVATIONS_013_048/drifter/history/GL_TS_DC_*.nc

In July 2019, Copernicus Marine service files moved from NetCDF3 to NetCDF4 format, to support new features such as data compression (smaller file size) or storage (add_offset and scale_factor on variables). The Copernicus NetCDF CF format are documented in:

- *Copernicus Marine in situ NetCDF format reference manual* *https://doi.org/10.13155/59938*

Surface current products, delayed mode

For the Global Ocean delayed mode in-situ observations of surface currents, use the following links to access to:

- *Rio Marie-Hélène, Etienne Hélène (2019). Copernicus Global Ocean delayed mode in-situ observations of ocean surface currents http://doi.org/10.17882/41334*
- Product user manual: http://doi.org/10.13155/41257
- Quality Information Document: http://doi.org/10.13155/41256

This product is updated once a year.

Météo-France QCTools

Météo-France operates quality control (QC) procedures on drifting buoys data. Buoy data QC tools developed by Météo-France are available on the Internet (http://esurfmar.meteo.fr/qctools/) to help buoy operators to check their own buoys: monthly statistics carried out by four meteorological centres for individual buoys; plots of data and differences with model outputs; blacklists of buoys reporting dubious air pressure values or being perhaps ashore can be seen.

DAC – Data Assembly Centre activity

Coriolis/Meteo France operates a Data Assembly Centre for drifting buoys.
The DAC function is to:

- Receive original drifting buoys data and preserve them
- Aggregate drifting buoys data and metadata into standardized NetCDF-CF files
- Decode and apply quality control in real-time
- Distribute quality controlled data on GDAC and GTS
- Manage updates (calibration, reprocessing) in delayed mode

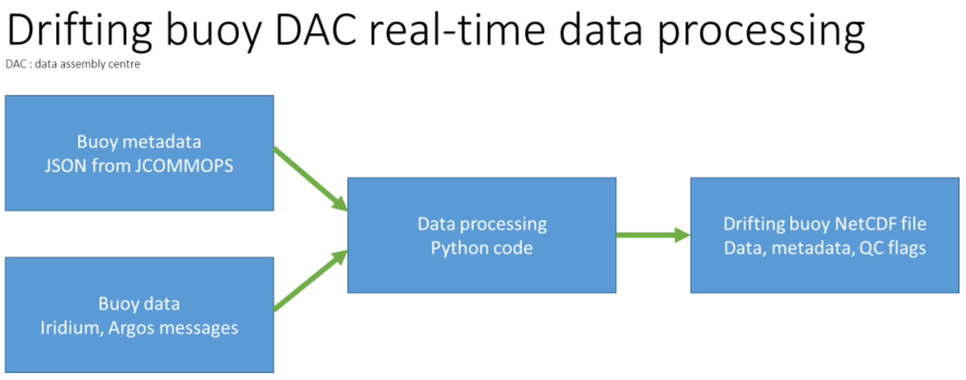
In September 2019, 534 drifting buoys with Iridium-SBD communication are managed by Coriolis-DAC, metadata is provided by JCOMMOPS.

Fisheries and Oceans Canada sends its drifters iridium data to Coriolis DAC.

Coriolis DAC may act as a DAC for SVP Iridium buoy data providers. This is realistic if the complexity and the number of type of buoys is not too big. Coriolis may also act as the DAC for orphan buoys whose data circulate on GTS only.

The drifting buoy data processing chain is freely available from:

- **Drifting buoys DAC data processing chain version 1.0** http://doi.org/10.17882/51148



GDAC – Global Data Assembly Centre activity

Coriolis operates a Global Data Assembly Centre for drifting buoys.
The GDAC function is to:

- Aggregate real-time and delayed-mode NetCDF-CF files provided by DACs
- Check the NetCDF-CF compliance of the DACs files
- Preserve NetCDF-CF drifting buoys files
- Distribute files on multiple channels
  FTP, HTTP, ERDDAP

The Drifting buoys GDAC MCDS is documented with:

- **Drifting buoys GDAC organization**
- **Drifting buoys GDAC NetCDF data and metadata format version 1.0**
  http://doi.org/10.13155/52037
- **Drifting buoys DAC data quality control manual version 1.0**
  http://doi.org/10.13155/52040
- **Drifter metadata in the WIGOS standard**
  https://doi.org/10.5281/zenodo.1406121

Drifting Buoys GDAC ftp server

The Drifting Buoys GDAC activity started in August 2018.

ftp://ftp.ifremer.fr/ifremer/dbcp-drifter

- gdac/active active drifting buoys
- gdac/history no more active buoys
- gdac-index.csv index of all GDAC drifting buoys

The gdac/active and gdac/history directories are populated with one file per buoy. The activity criteria is: observations within the last 30 days

Each file contains the buoy data and metadata (from JCOMMOPS).

The gdac/active is populated with iridium data received from Coriolis DAC (534 active Iridium-SBD drifting buoys in September 2019). The objective is to extend it to all history and active buoys managed by Meteo-France.

Historical data of drifting buoys with no access to original telemetry data may be recovered from AOML or MEDS historical GTS database.

The C-RAID project described in the following chapter is working on retrieving and reprocessing original drifting buoys data.

Drifting buoys GDAC ERDDAP access

The GDAC NetCDF files are also distributed on ERDDAP server

- DBCP GDAC ERDDAP server

Drifting buoys GDAC DOI access

A snapshot of the whole GDAC content is performed regularly (quarterly, monthly if required). The snapshot is preserved and published with a unique DOI: Digital Object Identifier.

- DBCP drifting buoys data and metadata from Global Data Assembly Centre (DBCP GDAC) https://doi.org/10.17882/57247
    - The DOI should systematically used for DBCP data citation: crucial for efficient bibliographic surveys.
    - The DOI and its associated fragment identifies a specific snapshot: crucial for reproducibility of result cited in scientific publications.

Statistics on drifting buoy data collected from GTS, Ifremer, SHOM

With Copernicus Marine funding, Coriolis (Météo-France, Ifremer) collects, quality controls, archives and distributes marine in situ data circulating on GTS or deployed by French and European institutions. Most of these data come from observation networks: drifting buoys, Argo floats, moorings, vessels, gliders or sea-mammals.

Observation networks

In 2019, Coriolis data centre managed 47 000 platforms including 13 040 drifting buoys.

To measure the impact of the observations available from these platforms on models using in situ data, we calculate a platform-day histogram.
Definition of platform-day: a platform that reported at least one observation on a day: +1.

In 2019, drifting buoys represent 45% of the platform-day observations.

The diagram below illustrates the importance of drifting buoys along animal, Argo float, mooring, glider and vessel observation networks.

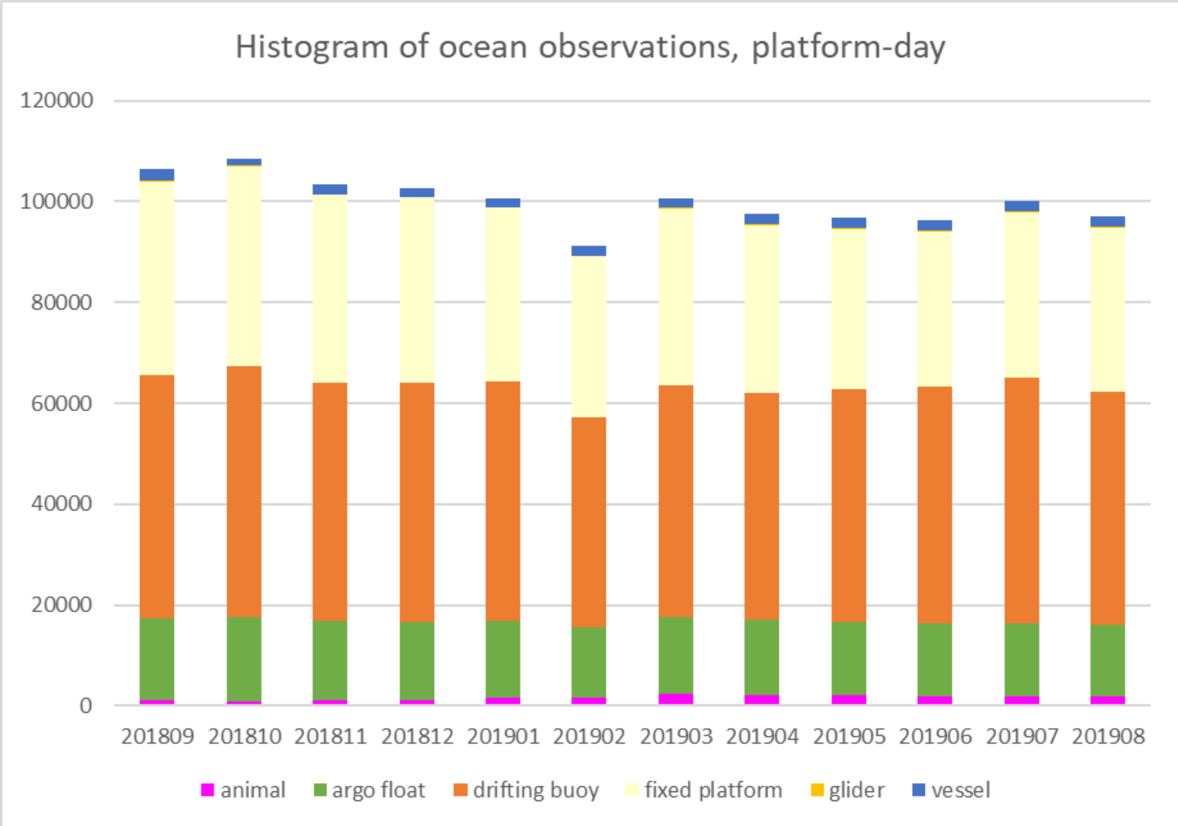


Figure 1: observation network observations in platform-day

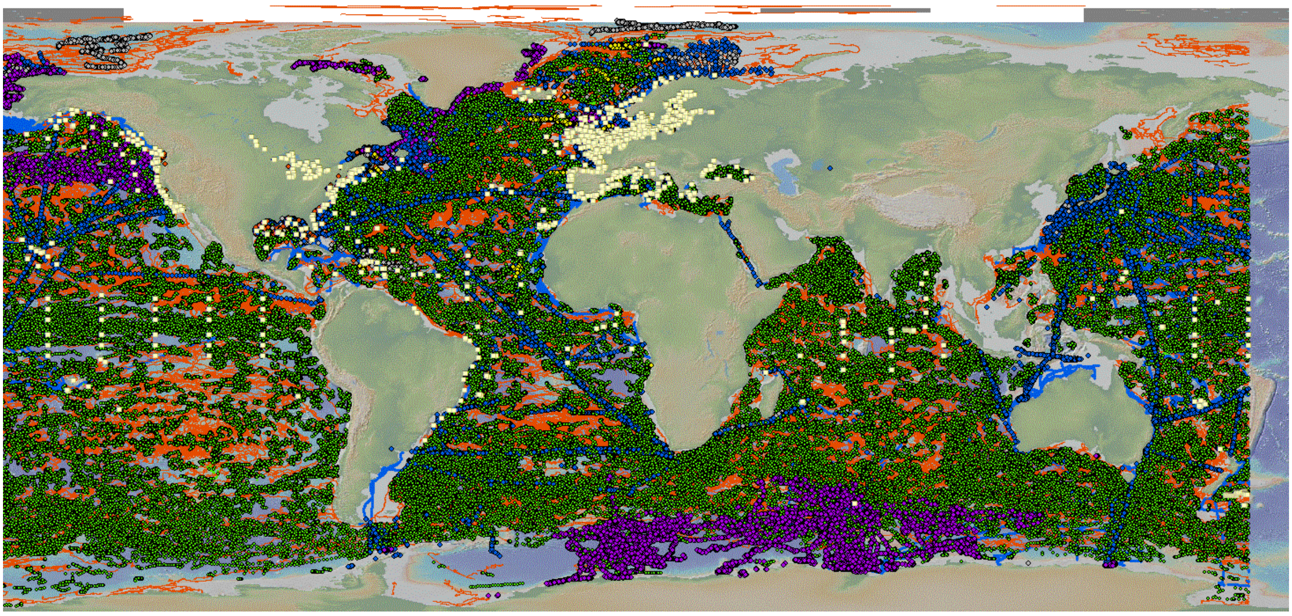


Figure 2: observation networks geographic coverage, 2018(one year)
The drifting buoys trajectories (red lines) are somewhat hidden by Argo profiles (green dots)

Drifting buoys observation network

In 2019, Coriolis Data Center managed 11 905 drifting buoys (+10% on 2018), more than 1700 were active.

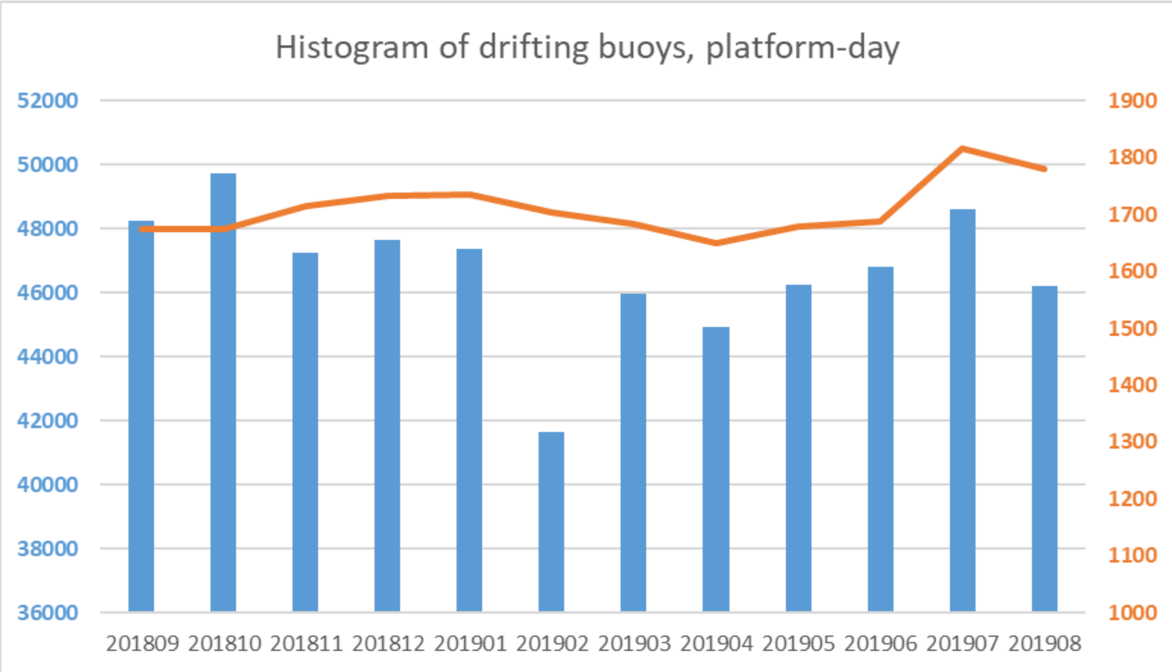


Figure 3: drifting buoys observations monthly distribution
(blue: platform-day, red: number of active platforms)

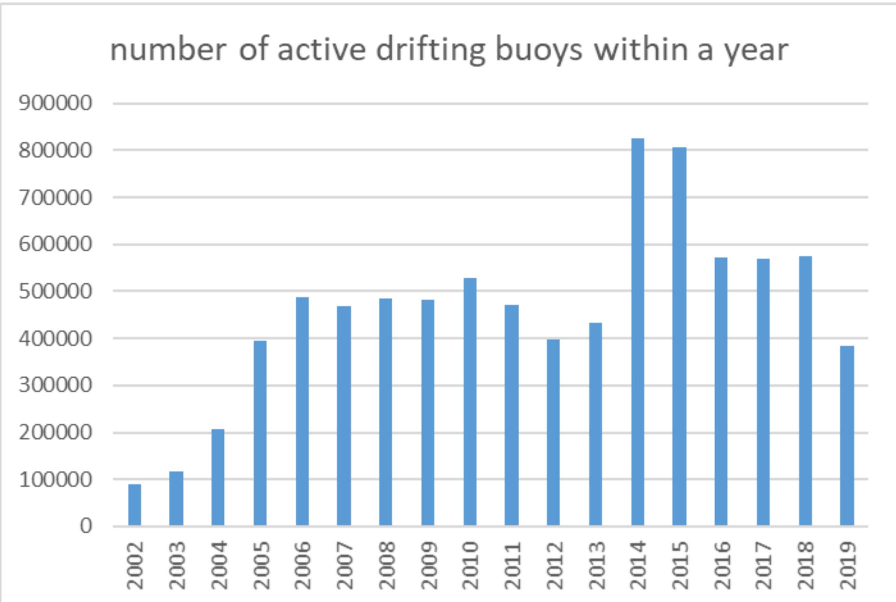


Figure 4: drifting buoys count, by year (count performed in September 2019, year 2019 is not complete)

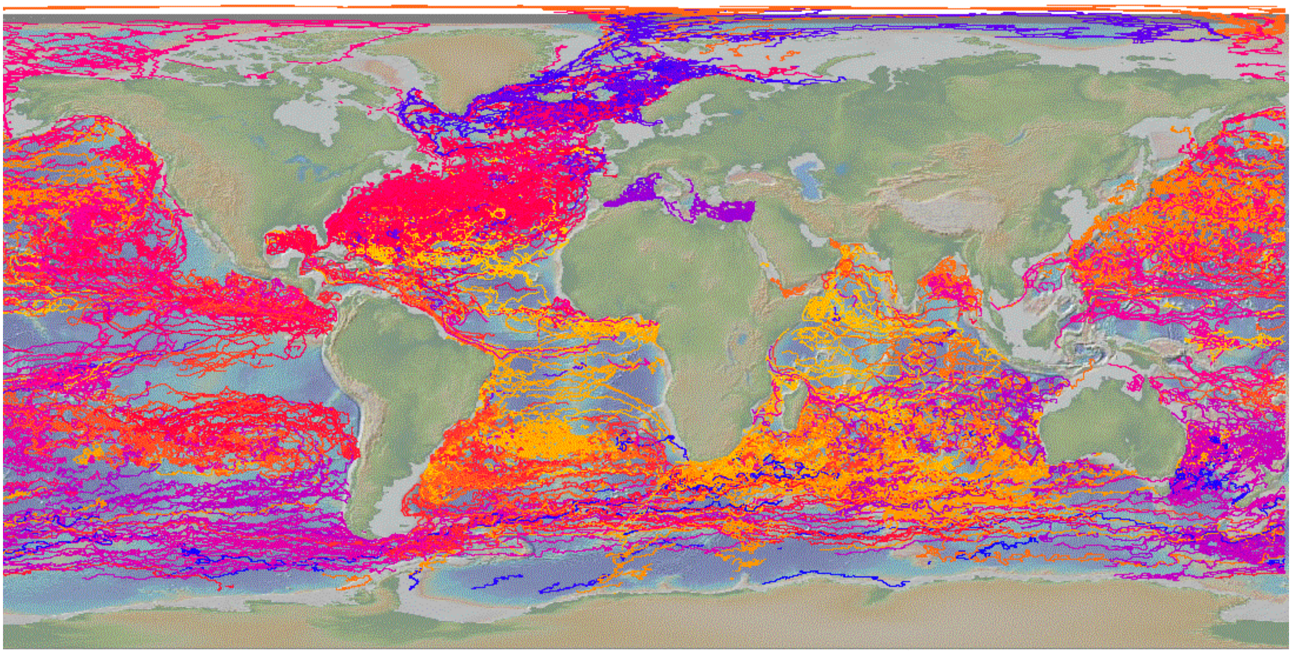


Figure 5: drifting buoys trajectories distributed by Coriolis - Copernicus in 2019 (one color one buoy).

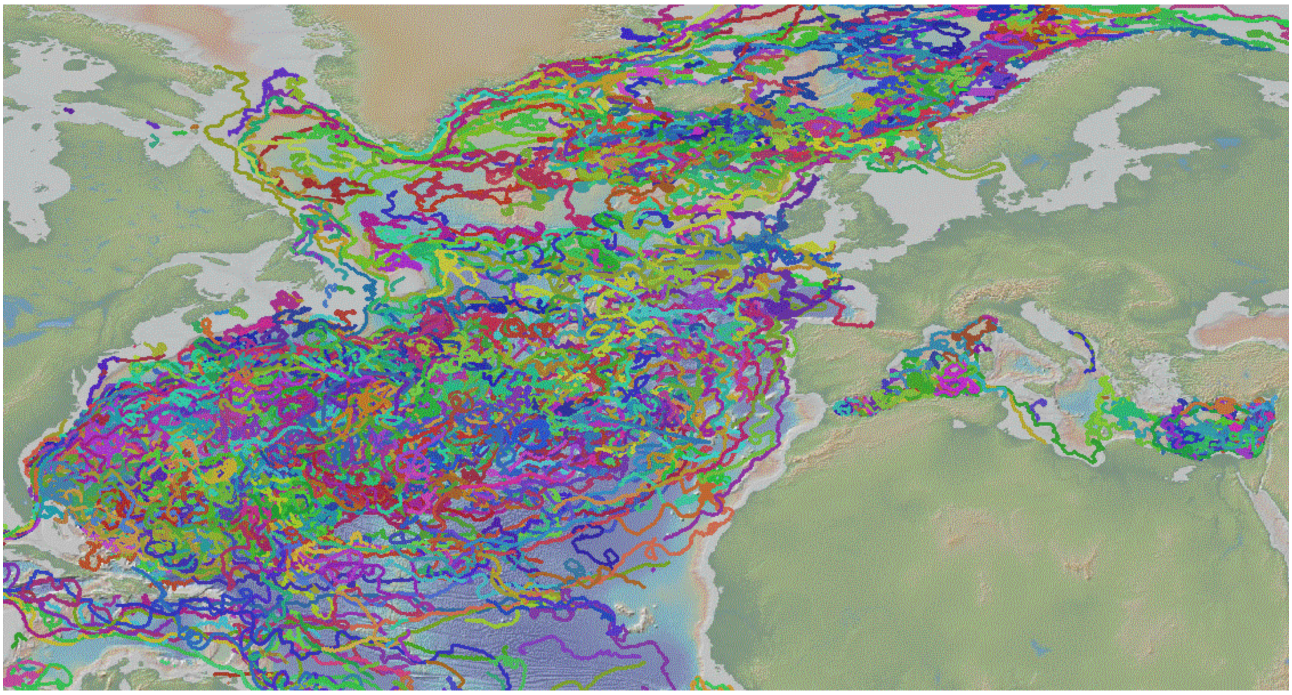


Figure 5a: drifting buoys trajectories, zoom on North Atlantic.

DAC GDAC Objectives 2019/2020

- Finalize the European DAC activity
- Initiate the activity of new DACs
- Organize the data management of orphan drifting buoys (no DAC)

C-RAID project contribution to Drifting Buoys GDAC

A new reprocessing project: C-RAID, Copernicus Reprocessing and Access Improvement for Drifter data

GDAC Context: An opportunity and a responsibility

The creation of the two Drifting Buoy GDACs a few years ago has put in place in the DBCP a framework for an improved quality control and delivery of drifting buoy of "climate quality" for the Marine Climate Data System (MCDS).

With this new paradigm, a responsibility for improving the climate records has been assigned. However, it has always been clear that the community would need to face its past regarding cleaning-up the entire data archive for the past buoys deployed, and that the GDACs alone would not be able to achieve this without additional support.

DBCP context

While some data buoy operators in the DBCP have done exemplary work with respect to curating the data collected by their programs (NOAA AOML in particular with its Drifter Data Assembly Center, reaching out also to other operators), there are great levels of disparity in the amount of expertise that has been added after the drifting buoy missions ended, to improve the data record, for the drifting buoy programs in general.

Importance of drifting buoys in the Earth system and timely opportunities

Recognizing that drifting buoys play a central role as references in the global observing system, these platforms are cited several times in the "implementation needs" of the Global Climate Observing System (GCOS: WMO, 2016). The conjuncture of a technological transition (from Argos to Iridium) is another factor to justify a reprocessing effort. Human expertise on the Argos system is also retiring, and data tapes are ageing.

Recognizing the needs for a reprocessed data record, the urgency to act, and based on strong recommendations from relevant Copernicus Services the European Environment Agency[4] (EEA), in its capacity as coordinator of the Copernicus[5]In Situ Component, decided to fund a project aimed at reprocessing the drifting buoy archive. The current project focuses on data buoys of the 'SVP' type. However, an extension to include FGGE buoys is being considered.

C-RAID project stakeholders

This project bridges to the key stakeholders in the domain, including CLS, the two GDACs (at CORIOLIS/IFREMER in France and at DFO in Canada), Météo-France, EUMETNET (with its E-SURFMAR program), but also builds on NOAA AOML and JCOMMOPS to ingest from, and then deliver to, improved data and metadata (respectively). Other archives or groups that ingest past drifting buoy data are set to benefit, such as iQUAM, ICOADS, GHRSST, ISPD, ICDC, CATDS…, only to name a few. In addition, the Copernicus Climate Change Service (C3S), with its reanalyses that assimilate marine in situ data to deliver a comprehensive set of Essential Climate Variables (EOVs) in a gridded form, and the Copernicus Marine Environment Monitoring Service (CMEMS), with its thematic products for several Essential Ocean Variables (EOVs), are also set to exploit the data to be delivered by the project.

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[4] For more information please visit https://www.eea.europa.eu/

[5] For more information please visit https://www.copernicus.eu/en and https://insitu.copernicus.eu/

This paper presents the key elements of work to be undertaken in the C-RAID project, with leads for future work and invitations to participate, if interested, from other DBCP players.

C-RAID project Deliverables

The main expected project deliverables are: 1) an improved drifting buoy data record for the time period 1997-2010 for SVP platforms, and 2) improved interfaces to access the drifting buoy data in the IFREMER GDAC, allowing data discovery for human users, and allowing efficient data download with an API for machine-to-machine data exchange.

C-RAID project tasks

The first project tasks revolve around the issue of data recovery. While there is a considerable archive already at AOML, an inspection of the CLS archive, which has been the sole data operator/provider for years, has shown that many years of data could probably gain to be reprocessed. Figure 1 shows a preliminary indication of the number of data per year. Investigations are ongoing to understand the gap between data holdings at CLS and AOML past 2008. While it is possible that some of the data missing at AOML (orange) were probably removed for a good reason (i.e. erroneous or bad quality data), the fact that entire buoy time-series and programs are missing is an indication that additional data could be rescued by the project, by working from the original CLS data archive.

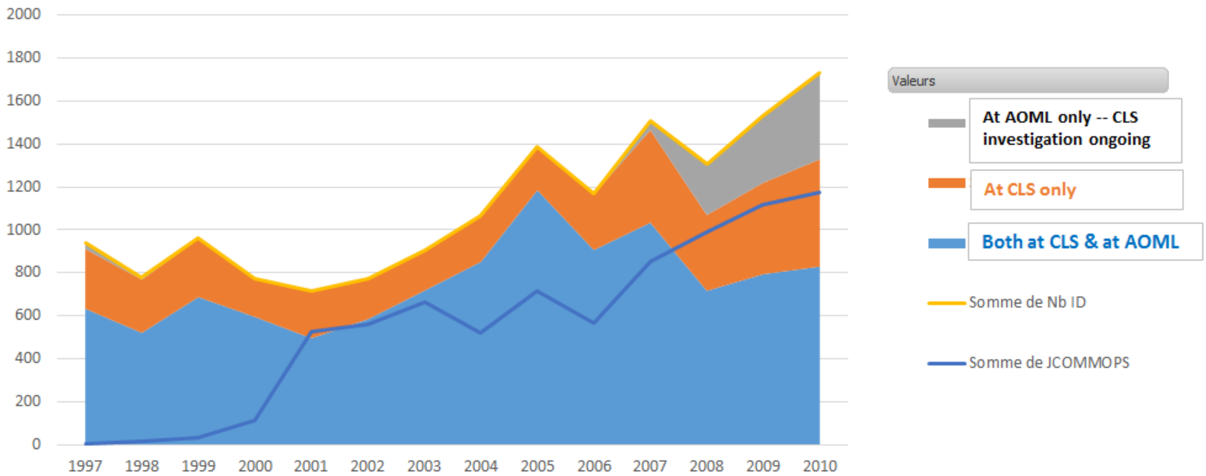

Figure 1. Number of unique Argos drifters per year in the AOML database only (grey – investigation ongoing), at CLS only (orange), and both at CLS & AOML (blue). Yellow curve indicates the total sum. Blue line shows the number of identifiers found in the JCOMMOPS database.

A second series of tasks will be about reprocessing the Argos positions from original telemetry data, when available, using the current, state-of-the-art Argos processing algorithms, which can deliver a much better position than earlier algorithms. Another enhancement will be made by applying automatic behavior algorithms to flag possibilities of buoys before deployment (on deck on in test), or ashore or picked-up. All these benefits (new algorithms applied to old data) are along the same concepts of satellite data rescue (Poli et al., 2017).

A third series of tasks focus on reconciling drifter data with metadata, to create a multi-variate time-series per drifter mission (most likely in NetCDF format). This will be done for the Argos and Iridium SVP drifters in the time period selected by the project. The products will include automatic QC, to be enhanced to take benefit from the availability of complete drifter time-series. In addition, reanalysis data will be co-located to the drifter times and positions, to help inform users on the contextual situation, and placed in the NetCDF.

The products will finally be archived on the GDAC, and the aforementioned interfaces will be developed.

Unknowns

Entering such a project opens up an incredible amount of new issues. Many have to do with the metadata and knowing what the drifter was actually measuring, and how. The Argos data that CLS has kept are not all well-documented, when users requested special data formats to be delivered in raw format. DBCP users with any information about past data compression formats for their drifter programs are invited to reach out to the project PIs (Thierry.Carval@ifremer.fr) and Frederique.Blanc@clsgroup.com).

References

Poli, P., D.P. Dee, R. Saunders, V.O. John, P. Rayer, J. Schulz, K. Holmlund, D. Coppens, D. Klaes, J.E. Johnson, A.E. Esfandiari, I.V. Gerasimov, E.B. Zamkoff, A.F. Al-Jazrawi, D. Santek, M. Albani, P. Brunel, K. Fennig, M. Schröder, S. Kobayashi, D. Oertel, W. Döhler, D. Spänkuch, and S. Bojinski, 2017: Recent Advances in Satellite Data Rescue. Bull. Amer. Meteor. Soc., 98, 1471–1484, https://doi.org/10.1175/BAMS-D-15-00194.1

WMO, 2016. The Global Observing System for Climate: Implementation Needs. GCOS- No. 200. https://library.wmo.int/doc_num.php?explnum_id=3417

CANADA DDB GDAC REPORT

CANADA DDB GDAC REPORT

The Marine Environmental Data Section (MEDS) of Fisheries and Oceans Canada (DFO) began operating as GDAC for Drifting Buoys in July 2017. The functions that MEDS performs are as follows:

- Acquire and decode real-time drifting buoy data transmitted on the GTS in BUFR TM315009 format
- Check compliance of BUFR messages and notify data providers as needed
- Monitor data stream for gaps and interruptions
- Contact GTS data providers as needed to recover missing data
- Perform comparisons of data received at MEDS with data available at NOAA OSMC and at CMEMS to address GTS routing issues
- Make data available by FTP

Data Flow

MEDS acquires drifting buoy data from the Global Telecommunication System (GTS) of the WMO through its National Meteorological Center (NMC) every 30 minutes. The Japan Meteorological Agency provides MEDS, on a best-effort basis, daily bundled collections of global drifting buoy data as received from its nearest World Meteorological Center through the GTS.

Data Distribution

MEDS makes all decoded BUFR drifting buoy data (TM315009) available on an ftp server with anonymous login: ftp://ftp.meds-sdmm.dfo-mpo.gc.ca/pub/DRIBU_BUFR/. Updates are done on a monthly basis. These data are routinely downloaded by the U.S. NOAA NCEI Center for Coasts, Oceans and Geophysics for inclusion in the International Comprehensive Ocean-Atmosphere Data Set. The WMO-IOC Centre for Marine-Meteorological and Oceanographic Data of Tianjin, China, have also been provided with the ftp address.

The data up to 2015 are archived and accessible from the U.S. NOAA data catalogue. Data distribution of recent drifting buoy data for the moment is by request only. The BUFR data from 2016 to 2017 have not yet been submitted since these needs to be integrated with the TAC data. BUFR data from 2017 onward are also still awaiting submission.

Summary of Work carried during the Year

Data Decoding / Archiving

Figure 1 shows the number of drifting buoy observations encoded as data subsets and transmitted on the GTS in BUFR TM315009 format per month over the last 13 months, as well as the number of unique platforms behind these observations. The colour coding represents the encoding / transmitting centre (see Table 1). Figure 2 shows the corresponding buoy tracks.

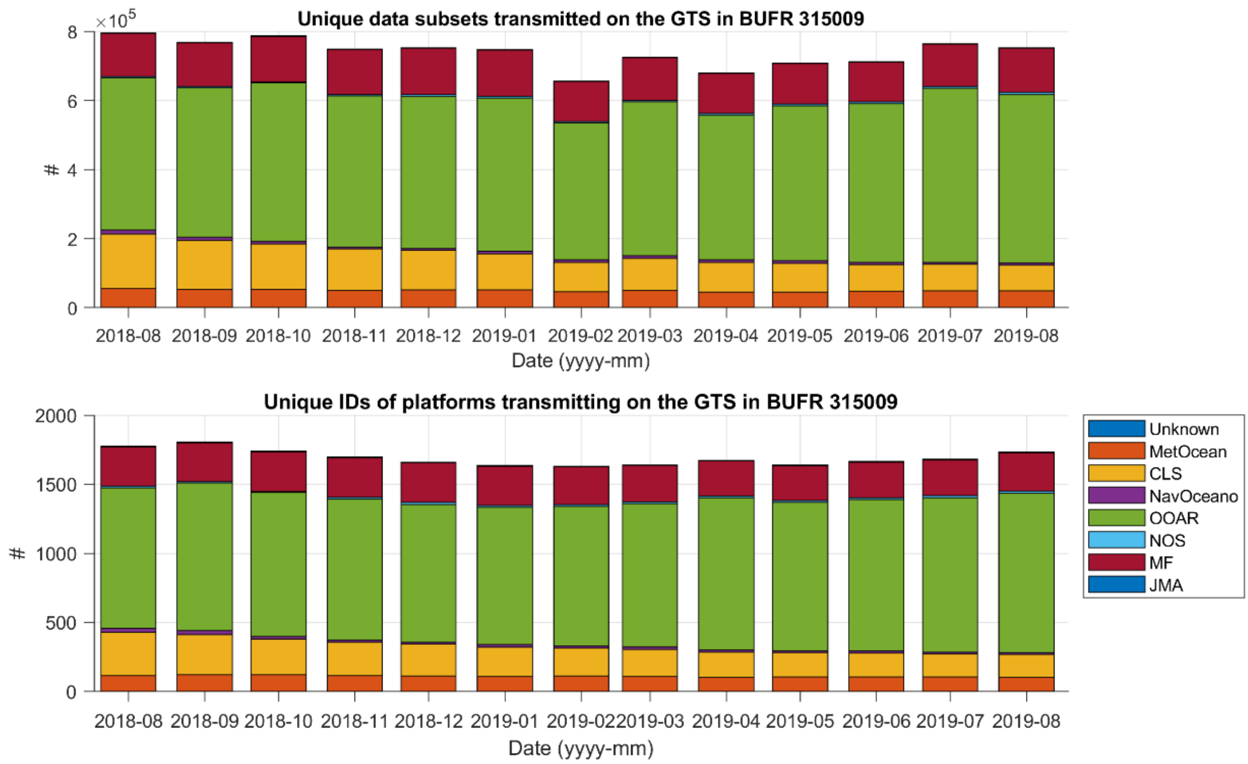

Figure 1: Bar chart of data received in the last 13 months

Table1: Symbols representing GTS encoding/ transmitting centres

Symbol	**Originating / generating centre (table C-1)**	**Bulletin heading(s)**	**Groups (according to JCOMMOPS)**
MetOcean	MSC Monitoring	CWAO (Canada)	DFO (Canada), ECCC (Canada), BOM (Australia), Met Service (New Zealand), Univ. Washington (USA)
CLS	Service ARGOS - Toulouse	KARS (USA), LFVW (France)	AOML (USA), ECCC (Canada), US NavOceano
NavOceano	US Naval Oceanographic Office	KWBC (USA)	AOML (USA), US NavOceano
OOAR	US NOAA Office of Oceanic and Atmospheric Research	KWBC (USA)	BOM (Australia), OGS (Italy), ECCC (Canada), AOML (USA), SIO (USA)
NOS	US NOAA National Ocean Service	KWBC (USA)	Univ. Washington (USA)
MF	Toulouse (RSMC)	LFPW (France), KWBC* (USA)	Meteo-France*, AOML (USA), EuMetNet, UK MetOffice
JMA	Tokyo (RSMC), Japan Meteorological Agency	RJTD (Japan)	

*84 Météo-France buoys reported alternatively in bulletins with KWBC and LFPW headers.

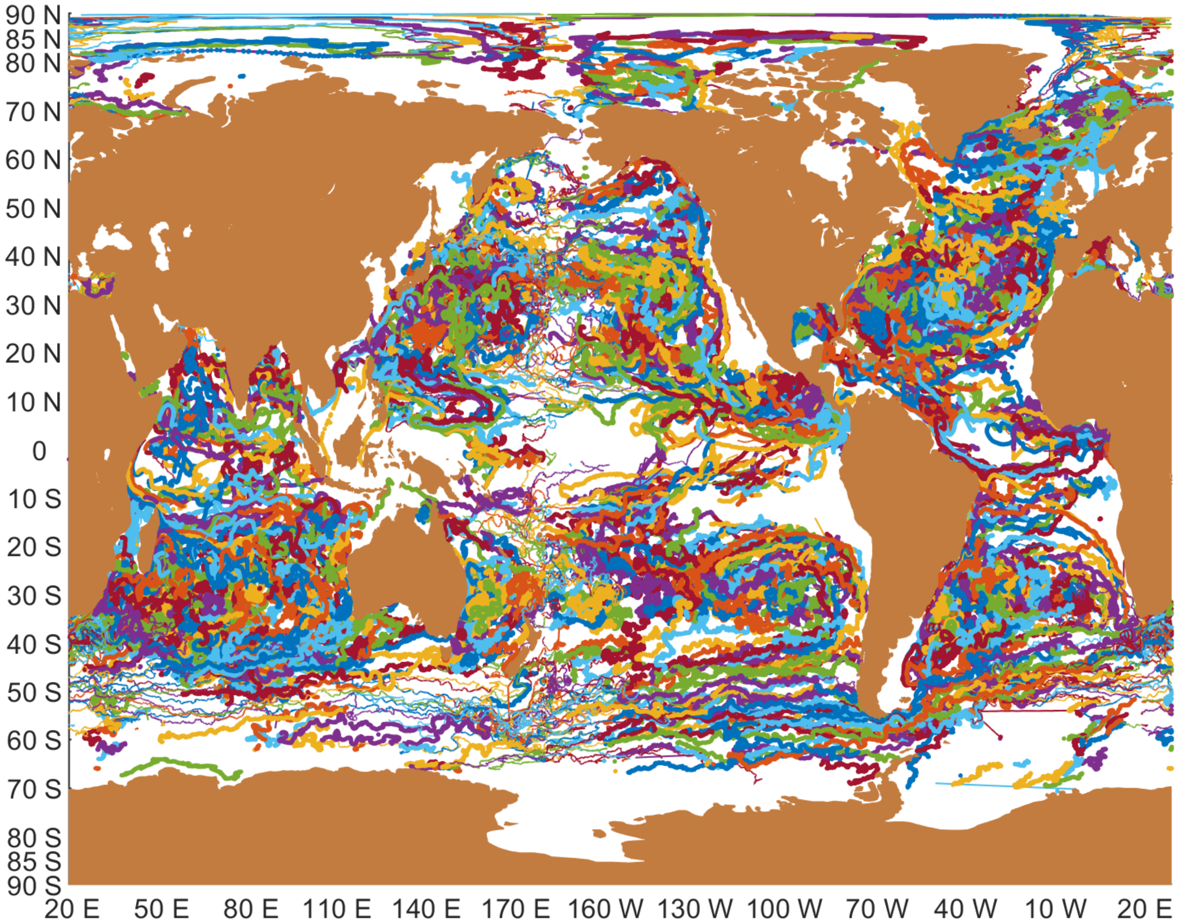

Figure 2 : Geographic coverage achieved by the buoys transmitting on the GTS in BUFR TM315009 format from August 2018 to August 2019 (13 months).

Data Completion Monitoring

MEDS monitors the data flow from various data assembly centres and attempts to identify outages and encoding errors in the incoming data. Data providers are contacted as required to address encoding issues and when possible to publish data in corrected form, while meteorological centres are contacted as required to address GTS transmission issues and to secure a better data feed. Outages or other issues were noticed at the following dates between September 2018 and September 2019:

- Météo-France, September 13-17 2018: The centre provided some of the missing data to MEDS in delayed-mode, but some of the data could not be recovered.
- SIO, 25 October 2018: Data could not be recovered.
- MetOcean, 20-26 November 2018: Wind data were incorrectly transmitted for Canadian buoys; the centre fixed the problem, and affected records were flagged in delayed-mode.
- SIO, 31 January to 10 April: Multiple brief interruptions only 1-2 hours in length occurred, as well as two larger gaps from 8-10 April; MEDS is still troubleshooting with the centre, and will import missing data in delayed-mode if possible.
- MetOcean, 9-11 March 2019: The centre corrected the issue and reposted the missing data on the GTS within 30 days.
- Météo-France, 6-7 June 2019: Centre was not able to recover the missed transmissions.

GTS Issues

In February and July of 2019, MEDS performed comparisons of GTS bulletin headings between their data, the data received by Météo-France and made available through the Copernicus Marine Environment Monitoring Service, and the data made available on the NOAA Observing System Monitoring Center ERDDAP server. The February analysis revealed 16 SHOM buoys for which data were made available in real-time on CMEMS but that were not transmitted over the GTS. The July analysis identified one buoy not reporting in the TM315009 format as well as five buoys with non-drifting buoy IDs reporting in this format; multiple WMO IDs that were never allocated at JCOMMOPS; multiple WMOIDs missing from one of the GTS, CMEMS, and OSMC data sets but present in others; and three bulletin headers likely never seen at OSMC.

Identification of duplicate bulletins and observations is an ongoing issue. In particular, cases were noted in 2018-2019 where multiple transmission attempts were associated with slightly different positions or times.

Metadata

MEDS routinely compares data collected from the GTS with the metadata stored at JCOMMOPS. 267 of the 2957 drifting buoys (9%) that reported at least once between August 2018 and August 2019 are not registered in the http://www.jcommops.org/ftp/DBCP/Status/dbcp_all.csv metadata file.

Objectives 2019/2020

- Finalize integration between TAC and BUFR data from 2015-2018
- Continue GTS monitoring
- Collaborate with Coriolis to identify additional DACs for orphan buoys
- Redefine own role in MCDS