Canadian Drifting Buoys Global Data Assembly Center Report

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1. Functions of Global Data Assemble Center

The Marine Environmental Data Section (MEDS) of Fisheries and Oceans Canada (DFO) began operating as Global Data Assembly Center (GDAC) for drifting buoys in July 2017. The performed GDAC functions are as follows:

- Acquire and decode real-time drifting buoy data transmitted on the Global Telecommunication System (GTS) in Binary Universal Form (BUFR) TM315009 format or any combinations data containing TM315009.
- Examine compliance of received BUFR messages and notify encoding / transmitting centers as needed.
- Monitor data stream for gaps and interruptions and contact encoding / transmitting centers as needed to recover missing data.
- Conduct data comparisons received at MEDS with the one available at NOAA Observing System Monitoring Center (OSMC) and at the Copernicus Marine Environment Monitoring Service (CMEMS) to address GTS routing issues.
- Distribute drifting buoy data on multiple channels such as FTP and website through data request.

2. Data Flow

Drifting buoy data is acquired by MEDS from the GTS of the World Meteorological Organization (WMO) through its National Meteorological Center (NMC) every 30 minutes. The Japan Meteorological Agency (JMA) provides MEDS, on a best-effort basis, daily bundled collections of drifting buoy data received from its nearest World Meteorological Center (WMC) through the GTS.

Recently, MEDS added a supplementary data pipeline through its NMC by using a more efficient tool called Sarracenia (https://github.com/MetPX/sarracenia). The real-time GTS data are synchronized to our local servers and python scripts are ran to wrap the data every 15 min.

3. Data Distribution

All decoded BUFR drifting buoy data (TM315009) are available on a FTP server with anonymous login: ftp://ftp.meds-sdmm.dfo-mpo.gc.ca/pub/DRIBU_BUFR/. They are updated to the server on a monthly basis and the server contains the data from 2015 to date. These data are routinely downloaded by the U.S. NOAA NCEI Centre for Coasts, Oceans and Geophysics for inclusion in the International Comprehensive Ocean-Atmosphere Data Set (ICOADS). The WMO-IOC Centre for Marine-Meteorological and Oceanographic Data (CMOC) of Tianjin, China, has also been provided with the FTP address.

The buoy data under Traditional Alphanumeric Codes (TAC) buoy category (ZZYY) from 1970s to today can be requested on a website: https://isdm.gc.ca/isdm-gdsi/request-commande/form-eng.asp.

4. Summary of Work

Although the WMO-mandated TAC-to-BUFR migration was to have been completed by November 2014, it is still far from finished. We still found TAC data transmitted on the GTS under buoy category (ZZYY). A closer examination of these buoy data reveals that they are extracted from tropical moored buoys and coastal wave moored buoys. That being said, all the drifting buoy data transmitted on the GTS are in BUFR format. This finding is consistent with the European Center for Medium-Range Weather Forecasts (ECMWF) migration report in 2018 (https://confluence.ecmwf.int/display/TCBUF/Drifting+buoys). We therefore report our findings and comparisons based on our BUFR drifting buoy data.

All BUFR-format data are decoded by our in-house Java packages and then archived in an Oracle database.

4.1 Temporal Variability

There are 8 data encoding / transmitting centers for drifting buoys and their symbols, related bulletin headings and their data providers can be seen in Table 1. The names of data provider groups are referenced to OceanOps metadata (https://www.ocean-ops.org/share/OceanOPS/GTS/wmo/wmo_list.txt).

Table1: GTS encoding/ transmitting centres with their bulletin headings and data provider groups.

Symbol	***Originating / generating centre (table C-1)***	***Bulletin heading(s)***	***Groups (according to OceanOps except KMA)***	***Average monthly subsets (1e4)***
MetOcean	MSC Monitoring	CWAO (Canada)	AWI (Germany), DFO (Canada), ECCC (Canada), USCG (USA), BOM (Australia), NOAA (USA), Univ. Washington (USA)	3.4±0.6
CLS	Service ARGOS - Toulouse	LFVW (France)	AARI (Russia), Meteo France (France), NIO (India), DBCP, NOAA (USA), US NavOceano (USA), Univ. Washington (USA)	2.4±0.7
NavOceano	US Naval Oceanographic Office	KWBC (USA)	US NavOceano (USA)	0.3±0.1
OOAR	US NOAA Office of Oceanic and Atmospheric Research	KWBC (USA), KWNB (USA), VHHH (Hong Kong)	BOM (Australia), JMA (Japan), Meteo France (France), Hong Kong (China), DBCP, SIO (USA), OGS (Italy), NOAA (USA), SAWS (South African), UK Meteorological Office (UK)	58.4±2.1
NOS	US NOAA National Ocean Service	KWBC (USA)	Univ. Washington (USA)	0.96±0.3
MF	Toulouse (RSMC)	LFPW (France)	Meteo-France (France), OGS (Italy), DBCP, SIO (USA), NOAA (USA), UK MetOffice (UK)	9.3±1.2
JMA	Tokyo (RSMC), Japan Meteorological Agency	RJTD (Japan)	Japan Meteorological Agency (Japan)	0.3±0.1
KMA	Seoul	RKSL(South Korea)	Korean Meteorological Administration (Korea)	0.1±0.1

The monthly drifting buoy subsets transmitted on the GTS over the last 13 months, as well as the respective numbers of monthly unique platforms, are shown in Figure 1 by grouping them into 8 encoding / transmitting centers. One subset is defined as one measurement reporting its location, time and all relevant data. On average, there are about 750,941 subsets received each month for the last 13 months with its standard deviation of 36,837 (Figure 1a).

Among the 8 centers, the data from OOAR represents a majority with a monthly average of 584,392 subsets (shown in Table 1 as well as the averages from other centers) transmitted on the GTS, 78% out of the total subsets.

The temporal variability of unique platforms transmitted on the GTS for the last 13 months is presented in Figure 1b. The average monthly platform reporting on the GTS is about 1,729 and the number of platforms from each encoding / transmitting center (their names in Table.1) is relatively stable for the last 13 months.

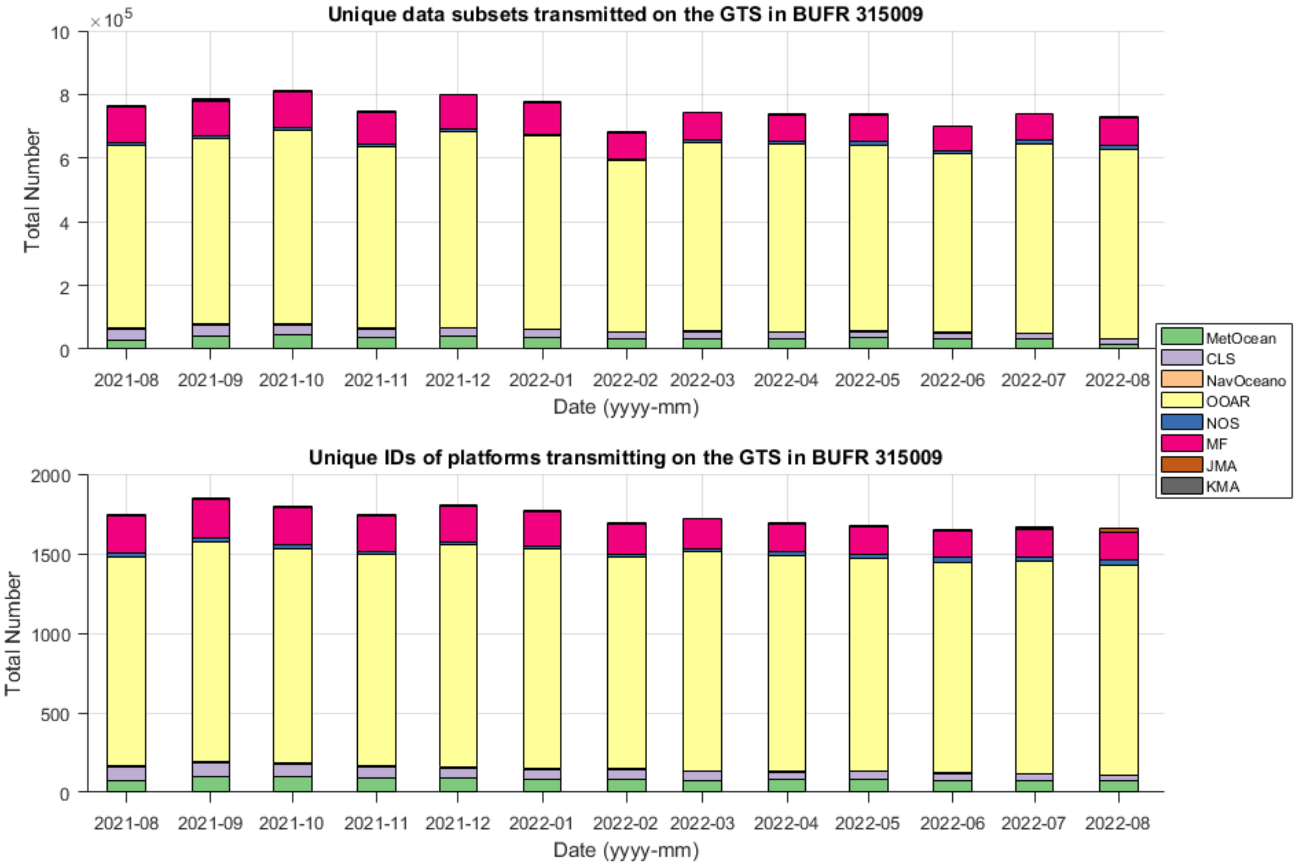

Figure 1: Monthly drifting buoy data subsets (a) and platforms (b) transmitted on the GTS for the last 13 months from 8 encoding / transmitting centers.

4.2 Spatial Distribution

We examined the spatial distributions of drifting buoys for the last 13 months by their tracks (Figure 2). The track map shows seven groups of tracks which are located in the North Atlantic, South Atlantic, East Pacific, West Pacific, Arctic, South Pacific and Indian Oceans. The track group is defined as an area that contains above-average numbers of buoy tracks, indicating frequent measurements in the area.

To better quantitatively examine the spatial distributions, we counted all the subsets at each $1^o \times 1^o$ for the last 13 months, and added them up to a total number of subsets (Figure 3). The total number of subsets ranges from 0 to ≥ 8000 for a period of 13 months, equivalent to $\sim$20 measurements per day on average. The locations containing a significant amount of subsets (Figure 3) are fairly consistent with the seven groups defined for Figure 2. For example, the area located at the Eastern Pacific off the USA west coast, and the Labrador Sea. The remarkable amount of subsets in these two areas is primarily attributed to anticyclone circulation of the subtropical gyre (gyre location can be referred to Figure 1 in reference [1]) in the North Pacific and cyclonic circulation of the subpolar gyre (gyre location can be referred to Figure 1 in reference [2]) in the North Atlantic with significant numbers of buoys trapped by the circulations. The hypothesis also applies to buoys trapped within the gyres of the southern hemisphere. The high data coverage in the Labrador Sea (Figure 3) allows for the potential of high quality datasets of annual mean surface conditions in the region. Contrarily, low coverage in other regions such as the Antarctic or Canadian Archipelago creates data sparsity, consequently leading to low quality datasets. Regional inconsistency for drifting buoys are expected considering large-scale gyre circulations along with unbalanced buoys deployed among regions. It is therefore recommended to include other observed data such as moored buoys data, remote sensing data or ship-based data to complete coverage of subsets in these low-coverage regions.

The fraction of the number of months in which at least one subset is available is shown in Figure 4 for the last 13 months. When no subset exists within the $1^o \times 1^o$ area, the indicated fraction would be 0 (0%), and when at least one subset exists every month within the $1^o \times 1^o$ area, the indicated fraction would be 1 (100%). There are some consistencies between the locations of high percentages (Figure 4) and the locations of significant amount of total subsets (Figure 3).

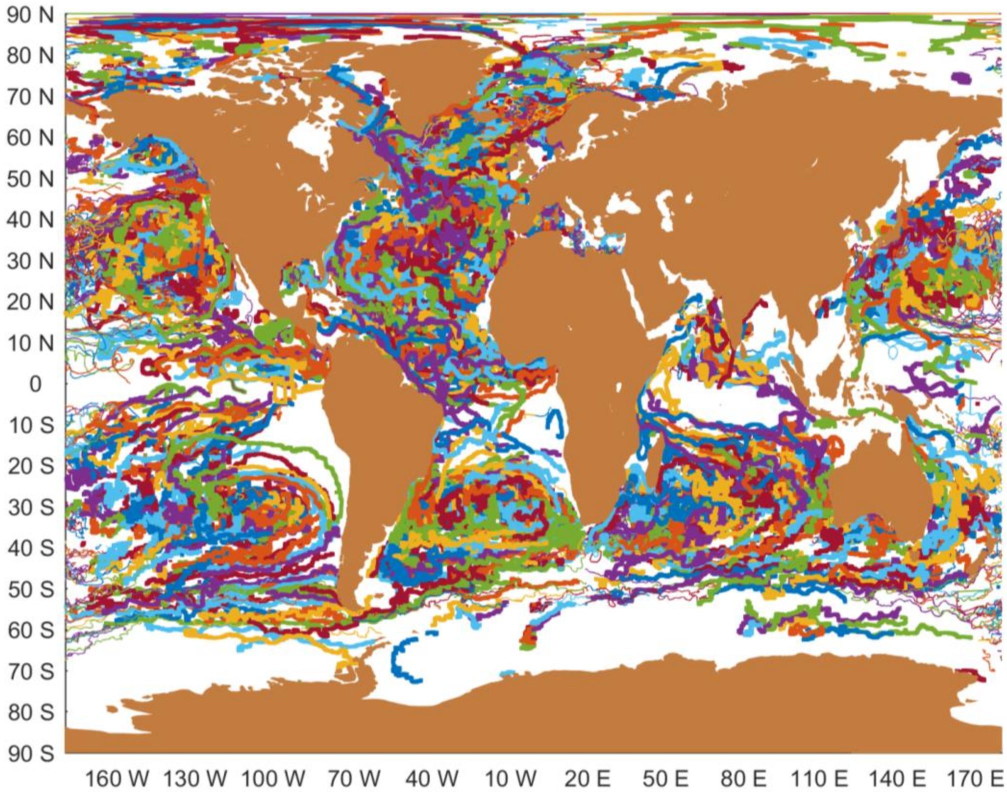

Figure 2 : Geographic coverage achieved by the buoys transmitting on the GTS in BUFR TM315009 format from August 2021 to August 2022 (13 months).

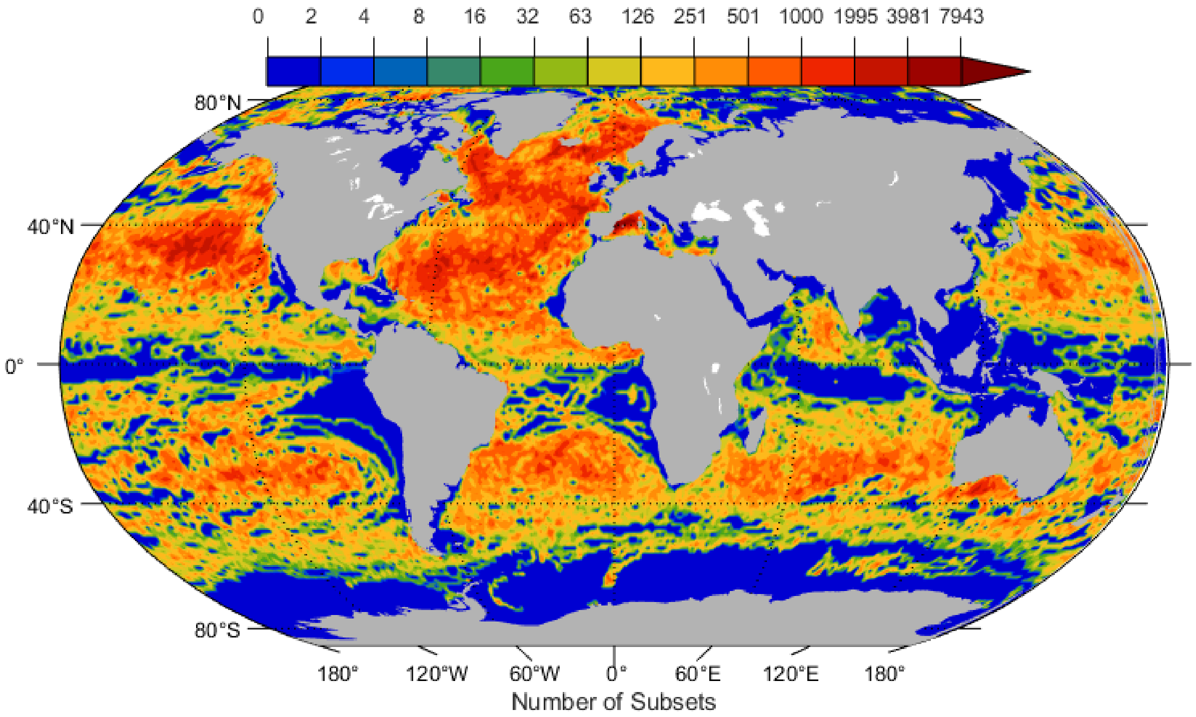

Figure 3: Map of total subsets for the last 13 months.

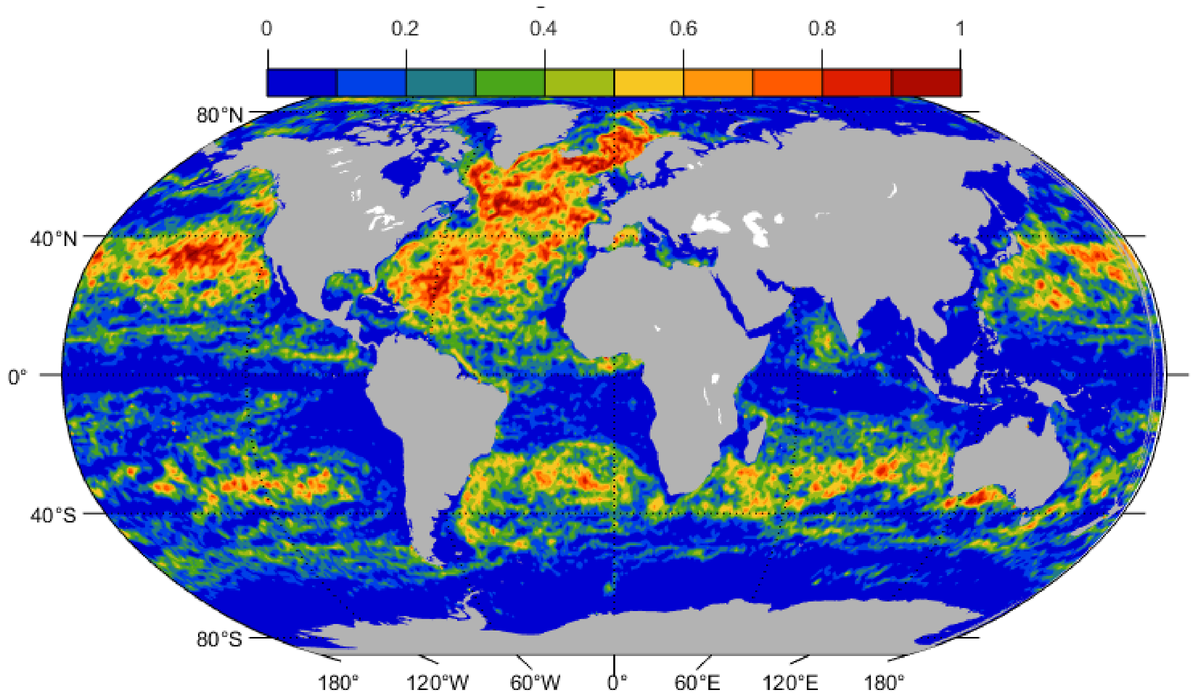

Figure 4: Map showing the subset fraction of the number of months in which at least one subset is available over the 13 months. When no subset is 0 and at least one subset existed every month, the fraction would be 1.

4.3 Data Completion Monitoring

Data flow from various Data Assembly Centres (DACs) is monitored in MEDS for any potential outages or encoding errors in incoming data. Data encoding / transmitting centers are contacted as required to address encoding issues and a potential schedule to publish data in corrected form, while NMCs 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 August 2021 and August 2022 (Table 2).

Table 2: Outages or other GTS issues between August 2020 and August 2021.

Bulletin Headings	Time	Issues	Actions	Results
IOBX, KWBC, RKSL	5-8 Jan 2022	Outage due to network issue	Detected	Partially recovered
IOBX18 CWAO	Occasional before 1 Feb 2022	Abnormal GTS time (wrong year)	Reported	Resolved
IOWX	Since November 2020	Extra wave spectral data not archived	Reported	Resolved
RJTD	Throughout September 2021	WMO ID's missing	Reported	Not resolved

5. Objectives 2022/2023

- Continue monitoring and reporting any identified GTS routing issues as well as any format issues.
- Redefine own role in the Marine Climate Data System (MCDS).

References:

[1] Karl, D. M., A sea of change: Biogeochemical variability in the North Pacific Subtropical Gyre. Ecosystems, Vol. 2. No. 3, 181-214. (1999).

[2] Hátún, H., Azetsu-Scott, K., Somavilla, R. et al. The subpolar gyre regulates silicate concentrations in the North Atlantic. Sci Rep 7, 14576 (2017). https://doi.org/10.1038/s41598-017-14837-4.