World Meteorological Organization &

Intergovernmental Oceanographic Commission (of UNESCO)

JOINT WMO/IOC TECHNICAL COMMISSION FOR

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JCOMMOPS Report

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Summary and Purpose of Document

This document provides a review of Argo data flow issues for year 2018, including notification process, real-time and delayed-mode data flow, metadata and latest developments realized by JCOMMOPS in support of Argo.
The ADMT is invited to comment on this document and take note of recommendations.

1. Argo status

Argo has reached 4000 operational floats in the last couple of months, and the reality should be lightly higher as several floats do not share their data yet.

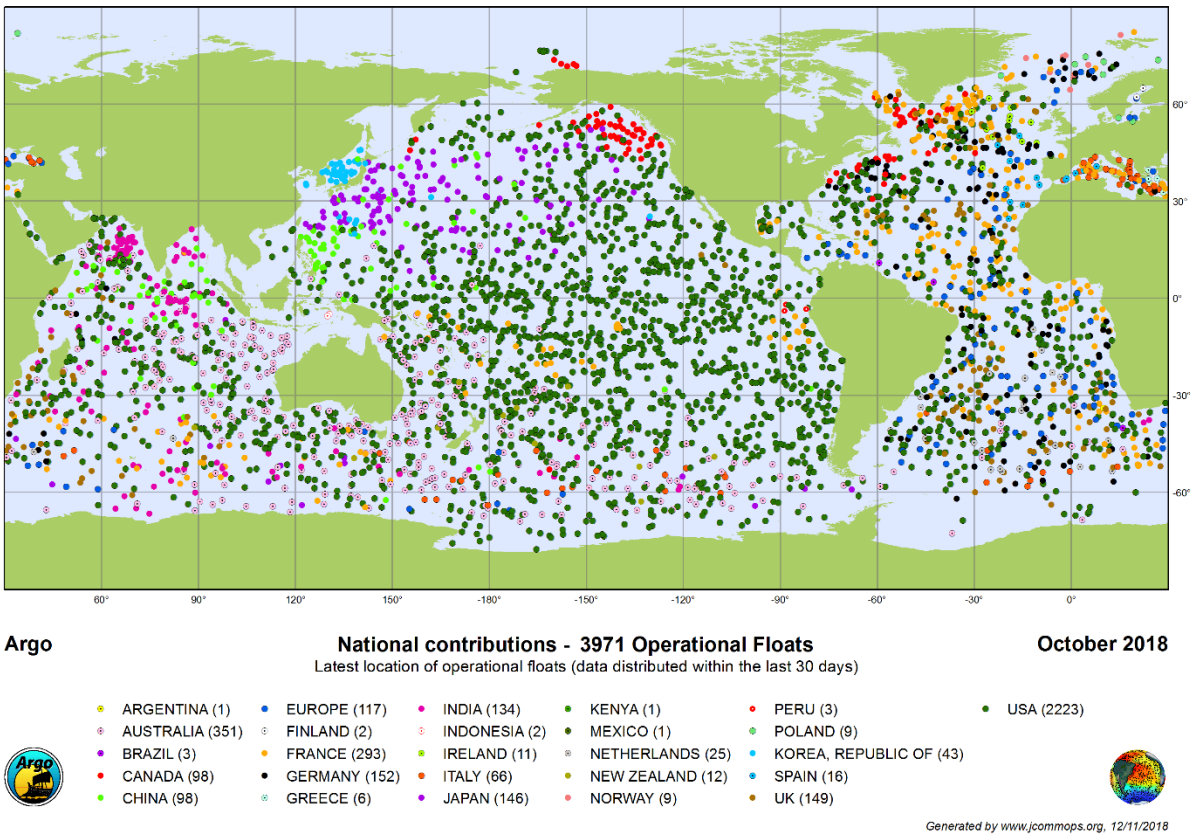


Fig. 1: Argo status by country, as of October 2018

Performance indicators on Argo implementation, based on the 3700 floats array target show an appropriate activity globally, and an intensity a little too short (84%) to meet the target based on 150 cycle lifetime floats. The increase of floats lifetime up to 250 cycles is critical to avoid an anticipated decay of the array.

Activity is slightly too high in North Atlantic and South West Pacific, and inadequate in the Southern Ocean seasonal ice zone (40%) and Marginal Seas (70%) (see Fig. 2).

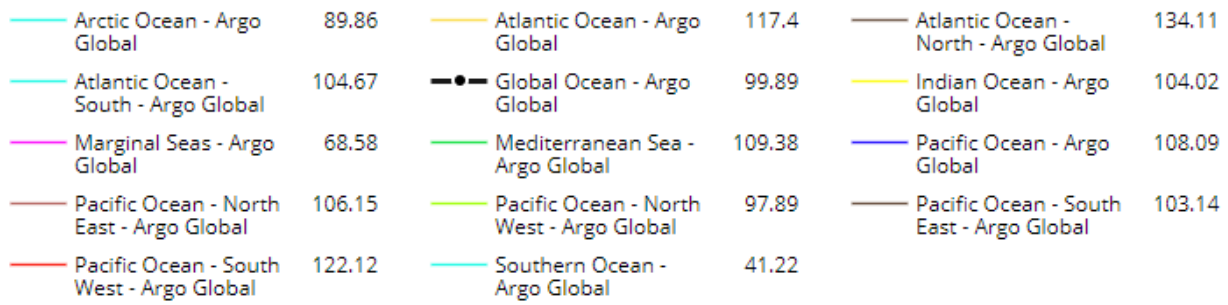


Fig.2: Argo activity by basin (%)

The intensity of yearly deployments is too low in the Southern Ocean (50%), in the Arctic ocean (30%), in the Indian Ocean (60%), in the Marginal Seas (65%), and too high in the North Atlantic and Mediterranean Sea (135%), and adequate elsewhere.

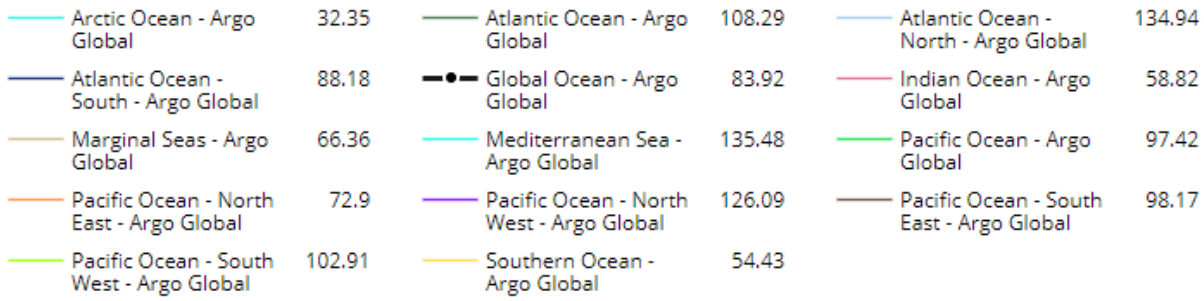


Fig.3: Argo intensity by basin (%)

The spatial distribution is good everywhere except in the Southern Ocean, with an even worse situation in the winter with 50% of iced over floats not transmitting data in real-time.

Reliability (010) Argo Global	80.79% 10/2018 ↘
Reliability (025) Argo Global	83.15% 10/2018 ↘
Reliability (050) Argo Global	89.21% 10/2018 ↗
Reliability (075) Argo Global	81.15% 10/2018 ↗
Reliability (100) Argo Global	74.73% 10/2018 ↘
Reliability (125) Argo Global	71.39% 10/2018 ↗
Reliability (150) Argo Global	59.77% 10/2018 ↗
Reliability (200) Argo Global	36.27% 10/2018 ↘
Reliability (250) Argo Global	18.98% 10/2018 ↗
Reliability (300) Argo Global	6.73% 10/2018 ↘
Reliability (350) Argo Global	4.7% 10/2018 ↗
Reliability (400) Argo Global	2.17% 10/2018 ↘

Fig.4: Float reliability vs targets

There is still room for improvement with float performance. 20% of floats fail in the first 100 days at sea and only 60% reach 150 cycles. The new ideal target of 250 cycles is achieved by 20 % of the fleet.

More details will be provided in the following sections of this report with regard to the data flow.
In short, the real time data delivery is good with 95% but can progress; the proportion of grey-listed floats was doubled in October 2018 to reach 10%; 90% of the floats send their data within 24h of observation date and the DM processing has gained recently 5% to be at its best level ever (75%).

The BGC Argo array (355 operating floats) is slowly progressing (37% activity, 65% intensity), see Fig. 5. Almost all BGC floats have oxygen, more than 200 have chlorophyll and backscatter and more than 100 have nitrate and pH.

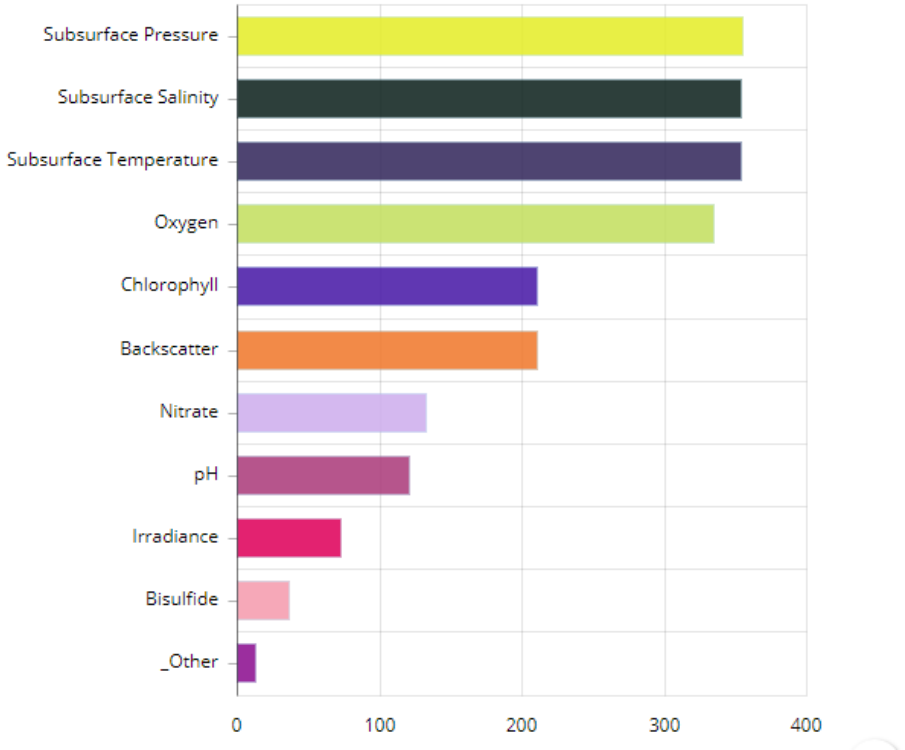


Fig.5: BGC Operational floats by variable.

Finally, while the US contribution remains stable, several national partners had a clear decreasing trend in the last years.

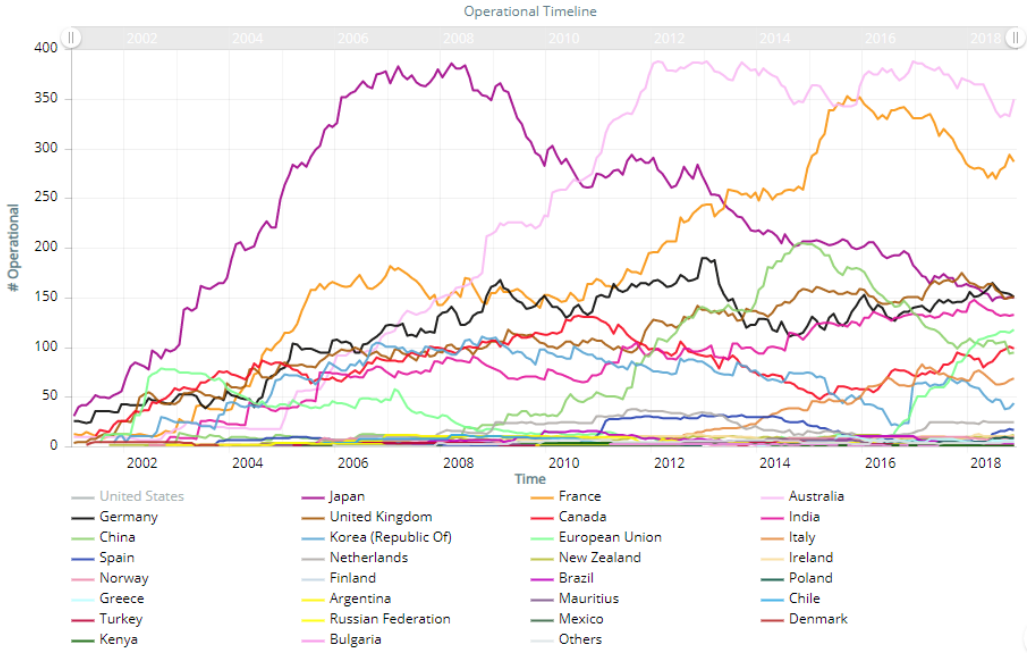


Fig.6: Evolution of operational floats by country (USA hidden for clarity).

A new vision and design for the future Argo array “Argo 2020” was discussed recently to reach a consensus on a truly integrated, global and multi-disciplinary array (Fig. 7). Several elements should be further discussed such as the equatorial enhancement in the Atlantic and Indian oceans or the priorities for the BGC array. Is it more important to have regional BGC pilot arrays with 6 variables, or a global one with less variables? Demand for a higher density of oxygen floats (BGC plans for ¼ of core floats) was also raised, including on deep floats.

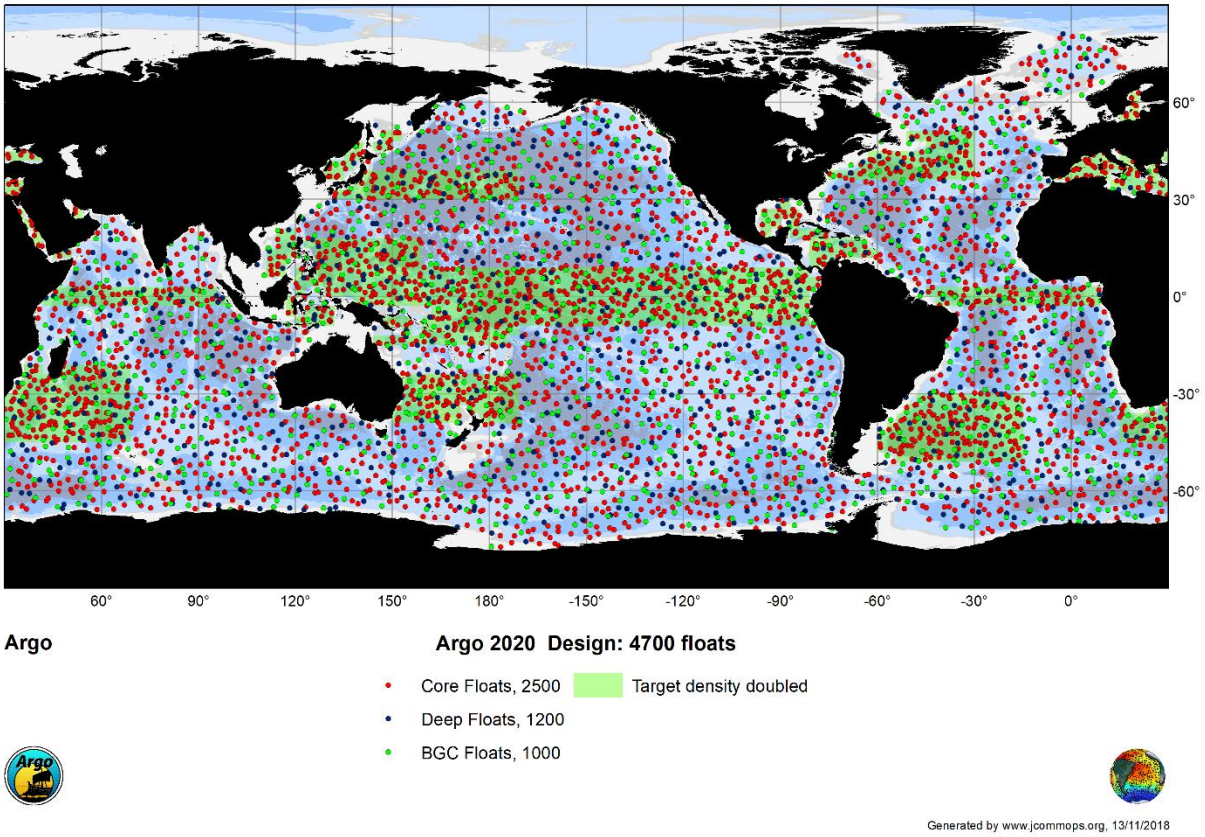


Fig.7: Argo 2020 sketch design

The Argo community will need to prepare an unprecedented communication strategy, with proper means and partners, to succeed in getting agencies and government supports for this future array, requesting roughly to triple national budgets.

Some other questions for the future should be discussed such as the “operationalization” of our data flow. Using Iridium and BGC floats, our national data management practices seem to have been further decentralized, beyond the ten established DACs. How this can be sustained and strengthened in the future.

Are our data services good enough for our community? Do we know well our data users?
We should perform a new users survey to gather their requirements and prepare the future of our data services.

2. Registration and Notification

The registration and notification of all float deployments, “reasonably in advance” is a mandatory activity to comply with international guidelines on float deployments and potential drift into Member States EEZs.
It is also critical to share deployment planning information across the Argo teams, anticipate the data processing, and enable a good tracking at JCOMMOPS.

All Argo programmes should have designated a responsible contact point to make sure the information if well captured in the JCOMMOPS system (http://argo.jcommops.org).
This activity can be made manually on line, by filling a form, either for individual records or by batch. The system currently reads most of netCDF formats, any CSV format, and some national text-based metadata files. The Argo Technical Coordinator assists with this activity but overall, 80% of the community is autonomous with registrations, which is a remarkable achievement.
There is rare negative feedback for this interface which means that it is rather operational, but JCOMMOPS will continue improve this system.

- ⇨ **Recommendation 1:** It is recalled that all float deployments should be registered at JCOMMOPS from draft plans, to formal registration with key metadata, before any data distribution is enabled.

A warning system is operated to inform a dozen of coastal states when floats approach their EEZs. This service is set by JCOMMOPS on implementer’s demand, but it is recommended to make it automatic, so all implementers can be recalled their duties.

- ⇨ **Recommendation 2:** Generalize the float warning system to all implementers.

Recently, one coastal state has requested to sequestrate data in its EEZ. GDACS and GTS data distribution should be interrupted while the float operate in these EEZs, and potentially never be made publicly available.
The ADMT should discuss with JCOMMOPS on how to set up a procedure to trigger some reactive steps to meet coastal states requests.
Member States requests could have varied specificities in time, space (EEZ, territorial sea, etc), or sensors.
Given the operational system in place at JCOMMOPS we could set a notification system from JCOMMOPS to GDACs to put floats in quarantine as long as necessary, without requesting the DACs to do a particular processing beyond switching off the GTS distribution.
Here is a first draft of what could be done:

Ideally only the first profile in the sensitive zone should be temporarily published.
At the first profile in the sensitive zone, JCOMMOPS raises the start flag and notifies the GDACs to put

the profiles in quarantine (a password protected area of the GDAC ftp e.g.) and the DACs to stop GTS distribution.

JCOMMOPS would run the geographical and other filters to notify GDACs and DACs, with a message including WMO_ID, PROFIL_NB_START, PROFILE_NB_END, and QUARANTINE_ENABLE/DISABLED.
GDACs would then move incoming profiles in the quarantine directory.
GDACs would have to set a special index files for such profiles so the tracking can continue at JCOMMOPS (reserved for administrators), and the end of quarantine would be notified when float moves out of the sensitive area, and GDACs could move back profiles in the right directory, and DACs enable GTS distribution.
Maybe we could let those references in the global index files.

Using the standard email subject, the procedure could be fully automated.

We could use and upgrade the current notification system set up for the QC feedback.

- ⇨ **Recommendation 3:** Discuss the procedure between JCOMMOPS, DACs and GDACs, to put floats in quarantine, minimizing the issues for data producers.

Finally, several floats and progammes are tagged as “Argo equivalent” (5%). Based on recent requests for clarification from coastal states it would be better to name these floats as “non Argo” to relieve further our control and responsibilities.

- ⇨ **Recommendation 4:** Rename “Argo equivalent” in “non-Argo”

3. Real-time data flow

a. Delivery

At the time of this report, about 150 floats are operating, and were deployed in the last 3 years, but data processing is not enabled. This metric is usually between 3 and 5 % of the operational fleet and shows the running window of floats to be processed. But 10% of floats deployed in 2018 do not yet share data. What is a reasonable delay to enable the data processing for a float? Ideally, everything should be ready before the deployment.

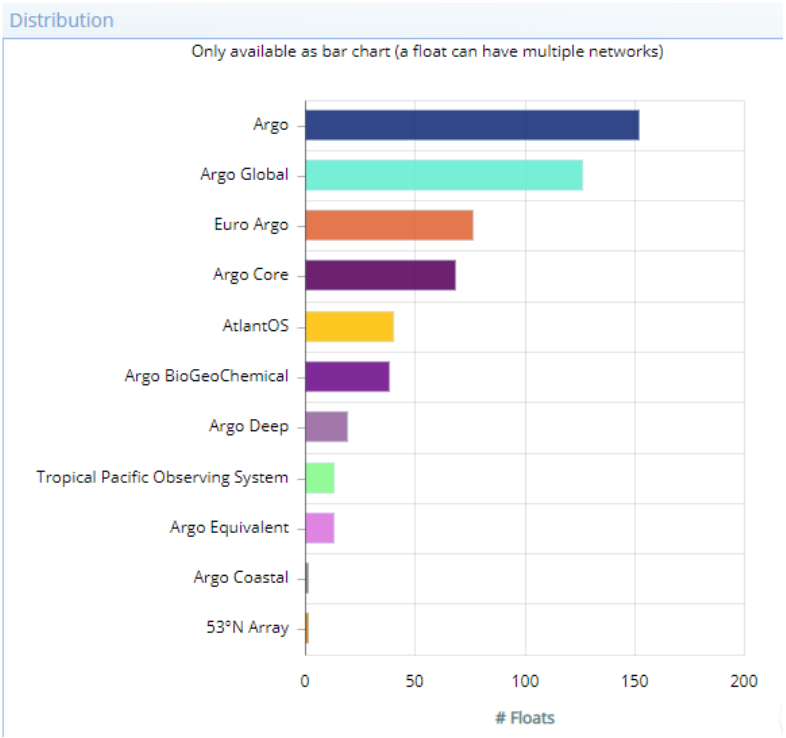


Fig.8: Floats pending data distribution (status='REGISTERED' and deployment date < today, as of 2018-11-26), by network

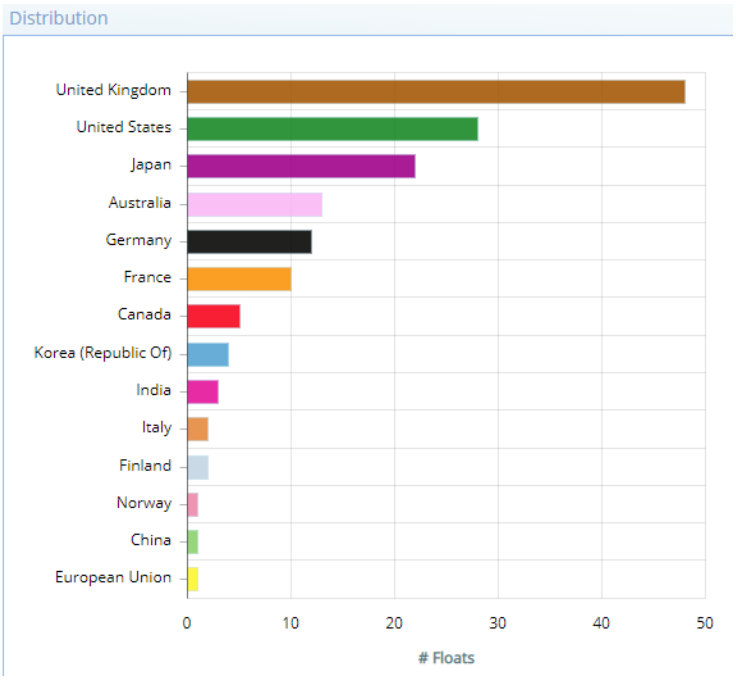


Fig.9: Floats pending data distribution, by country

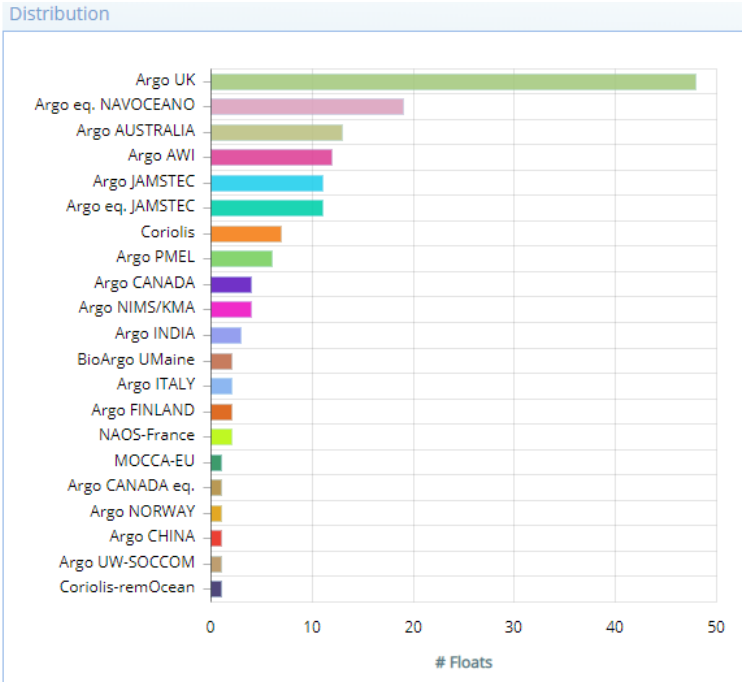


Fig.10: Floats pending data distribution, by program

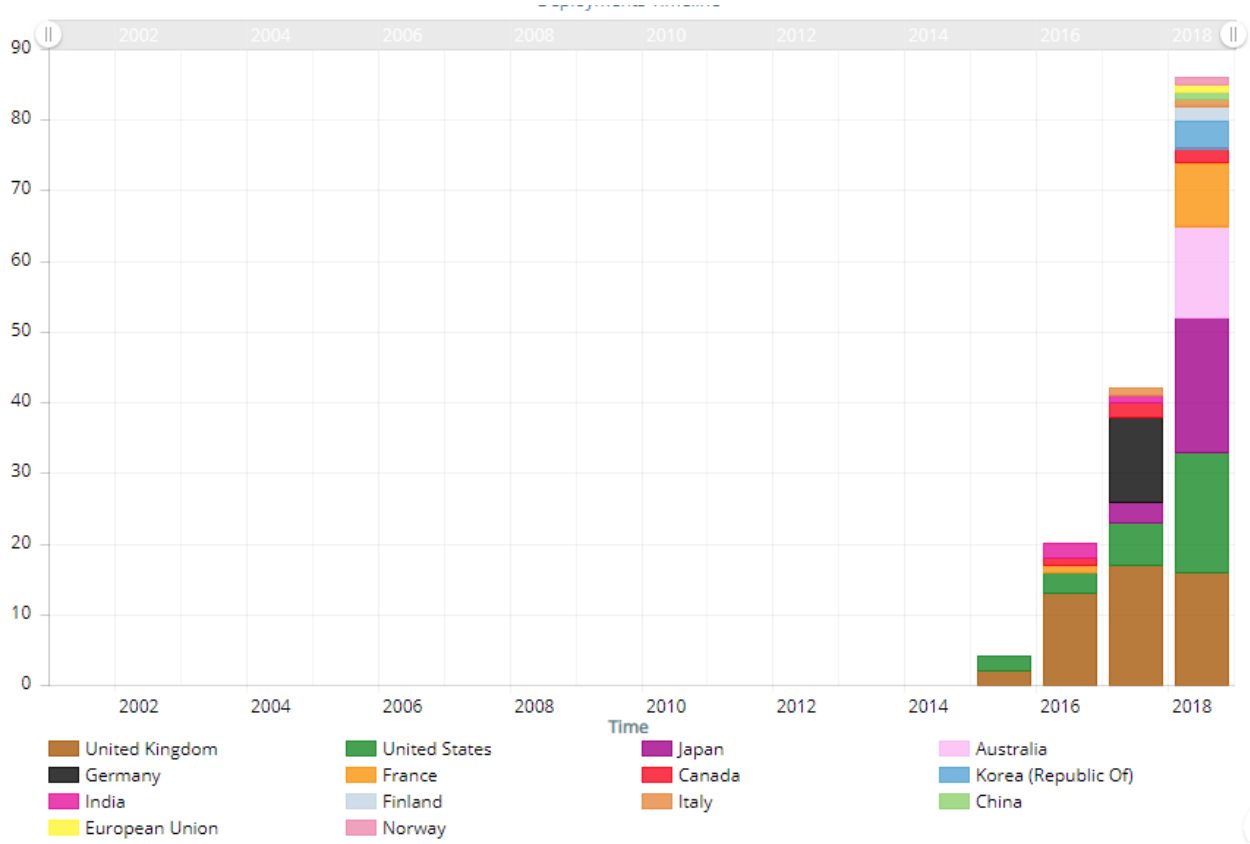
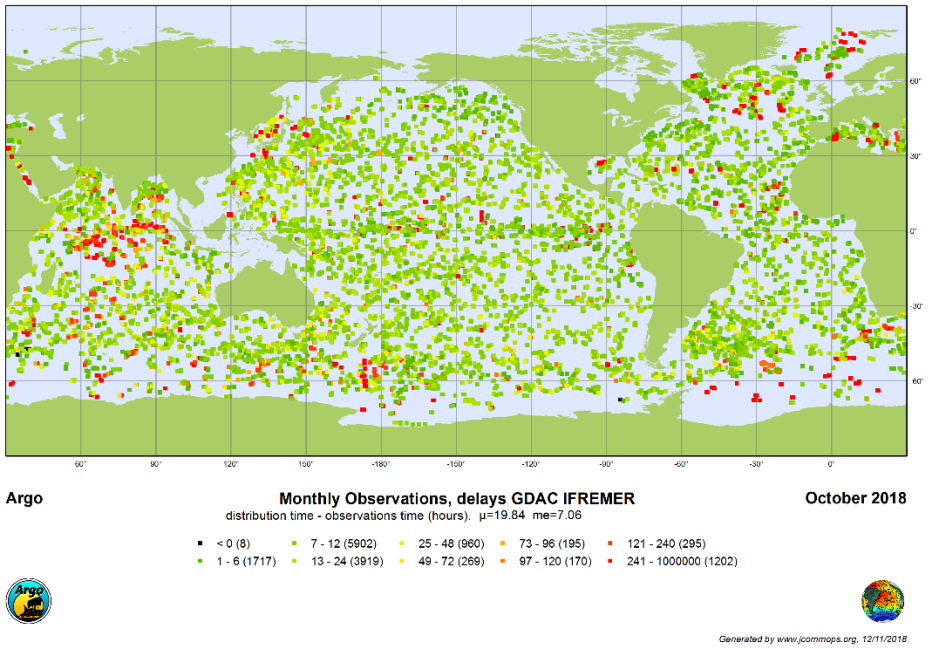


Fig.11: Floats pending data distribution, deployment timeline, by country

⇨ **Recommendation 4:** Sharing the data of deployed floats in real-time is an obligation to comply with international regulations. It should be the first of DAC priorities. Such duty is even more important when floats do not operate in high seas or in national waters of the implementer.

b. Delays

It is to be noted first that JCOMMOPS recovered the capacity to track GTS data distribution (from Meteo-France node). For a while many floats were missing from our GTS feed. The switch to BUFR permitted to review and improve the process.



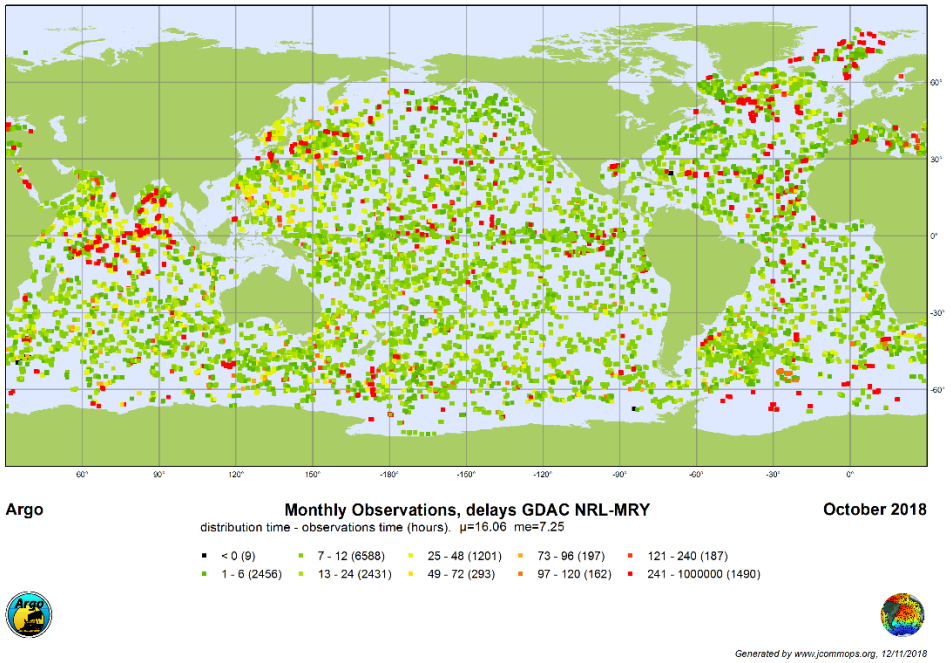


Fig.12,13: GDACs delays

The overall delays at GDACs shows a median of 7 hours. For some reasons the US GDACs has a better mean (16h vs 20h for Coriolis). Some float data might reach the French GDAC through synchronization only.

On November 11th we checked the median delays at GDACs for the 10 first days of observations of the month.

BODC	4.83	KMA	20.5	KORDI	24.73	JMA	9.2	INCOIS	6
CSIRO	4.95	SOA/SIO-2	4.65	ISDM	7.15	NOAA/AOML	7.83	CORIOLIS	3.36

Fig.14: Median Delays by DAC

BODC	3.08	INCOIS	2.91	JMA	4.69	CSIRO	4.16	SOA/SIO-2	4.14
ISDM	7.15	NOAA/AOML	8.32	CORIOLIS	2.68				

Fig.15: Median Delays by DAC, Iridium floats only

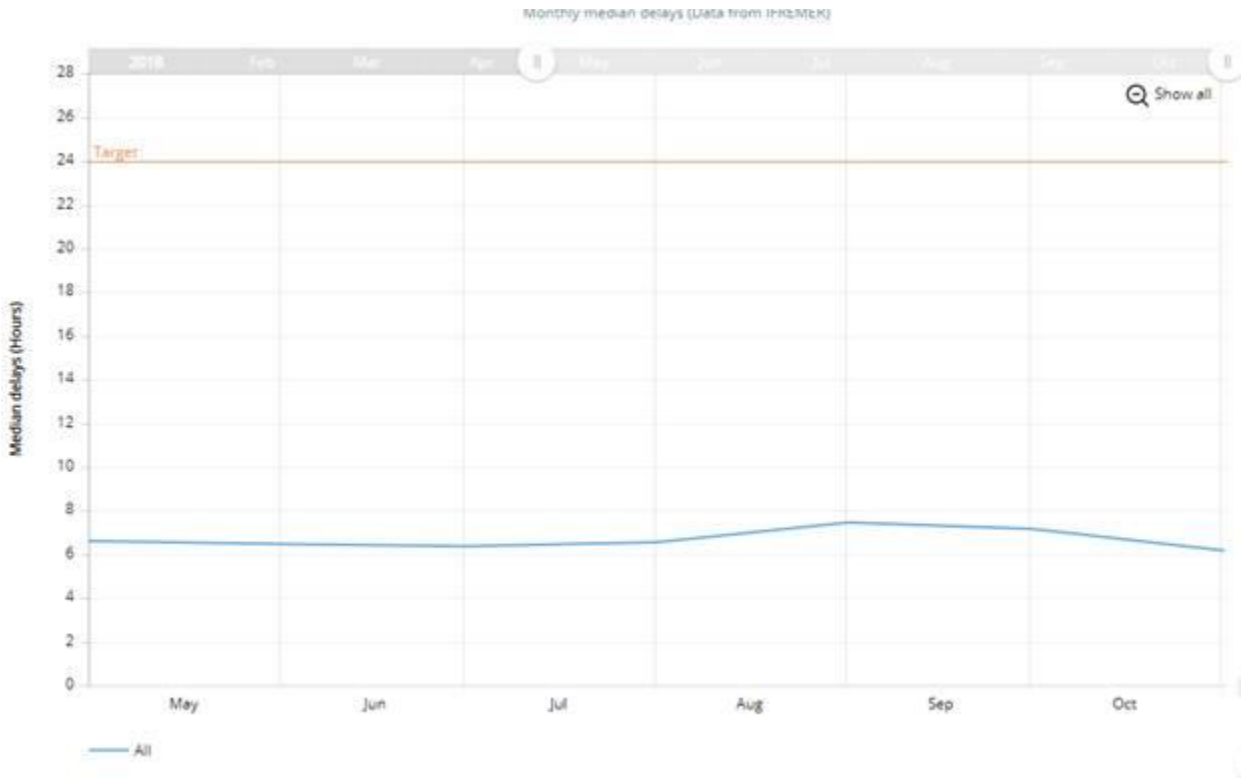


Fig.16: Median Delays 2018.

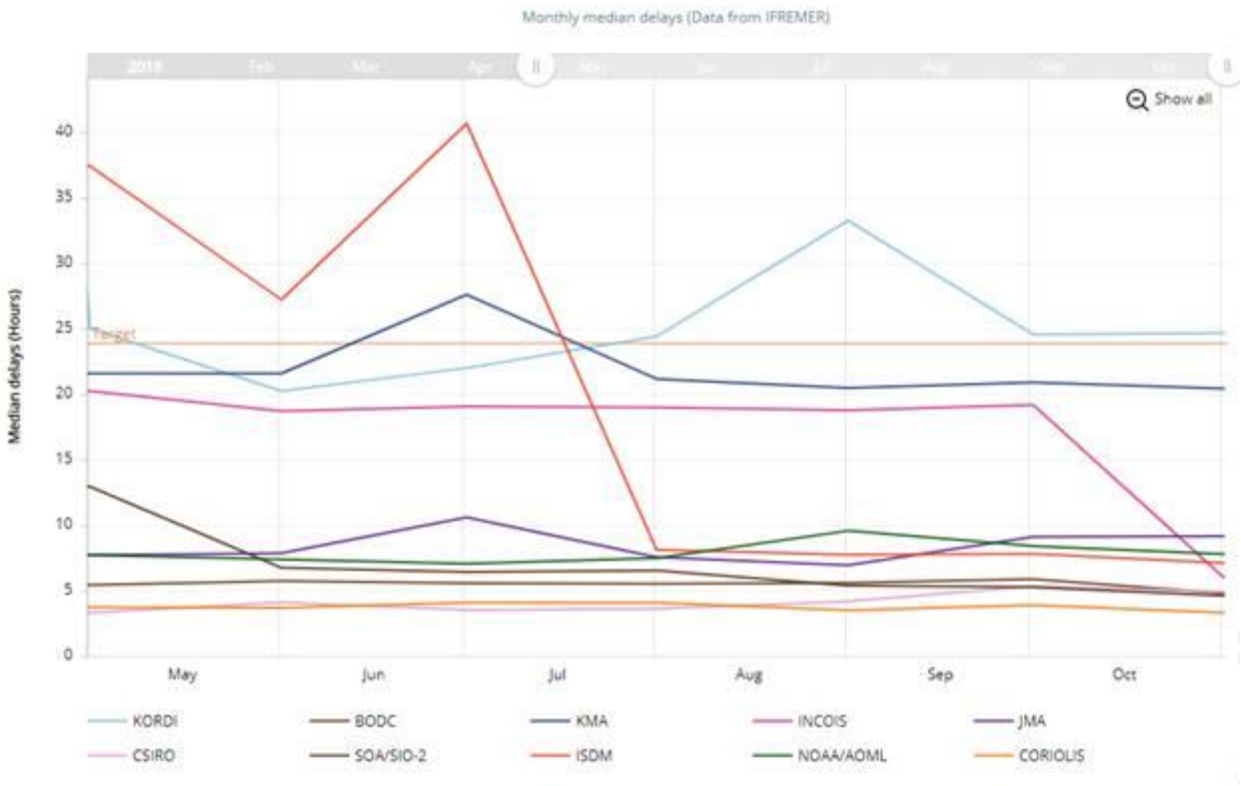
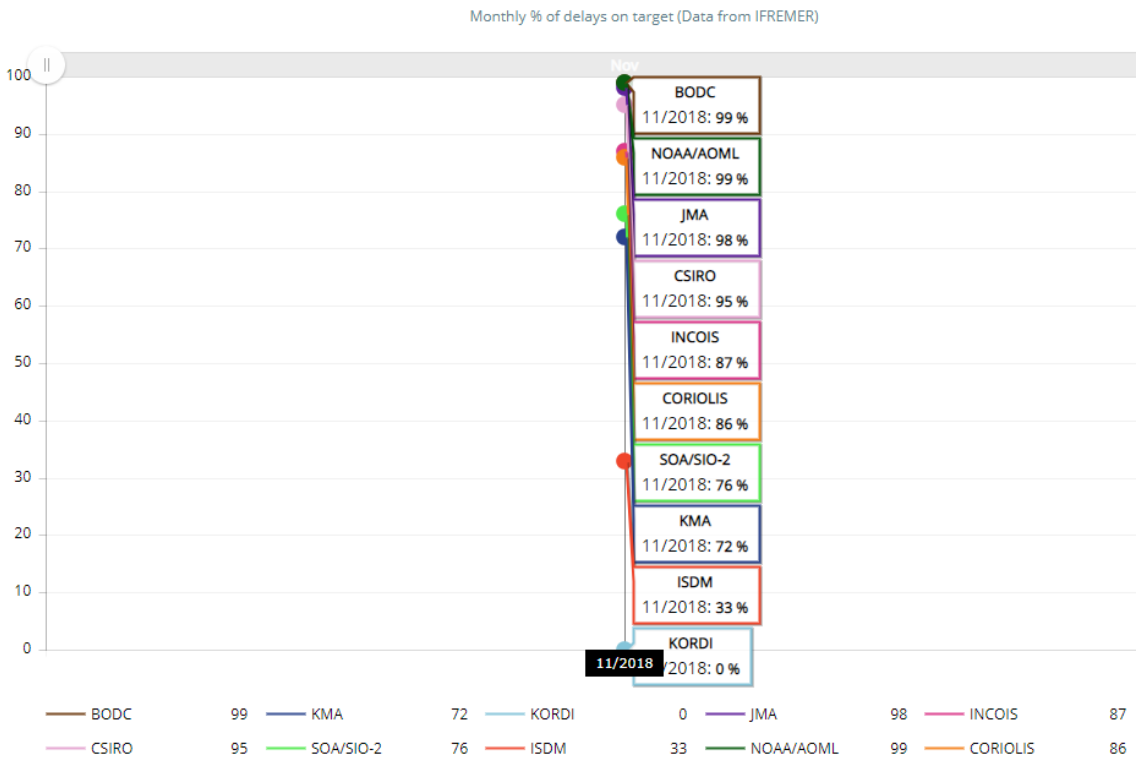


Fig.17: Median Delays 2018, by DAC

Several DACs have improved their delays recently and there is still margin for progress for some others. On Nov 27th, a new check was performed for observation made between 15-25 Nov.



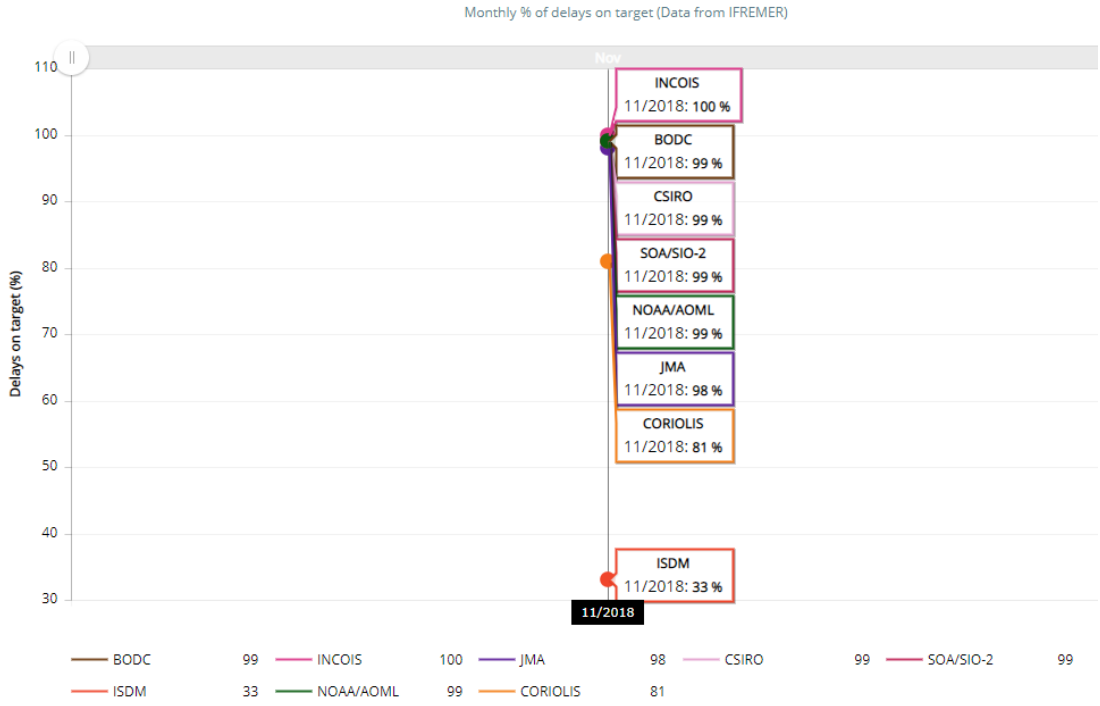


Fig.18-19: % delays on target (24h): All, and Iridium only

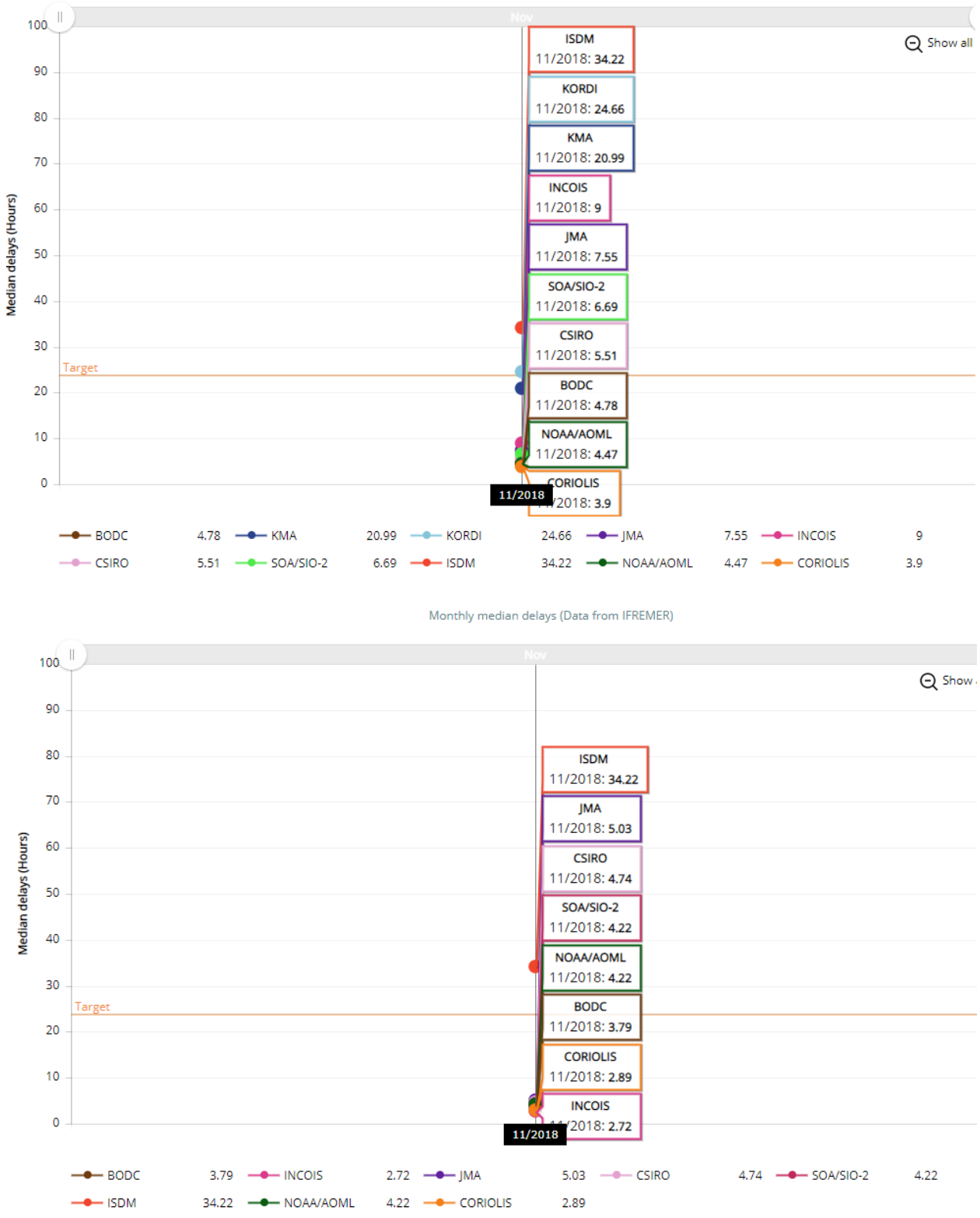


Fig.20,21: Median delays: All, and Iridium only

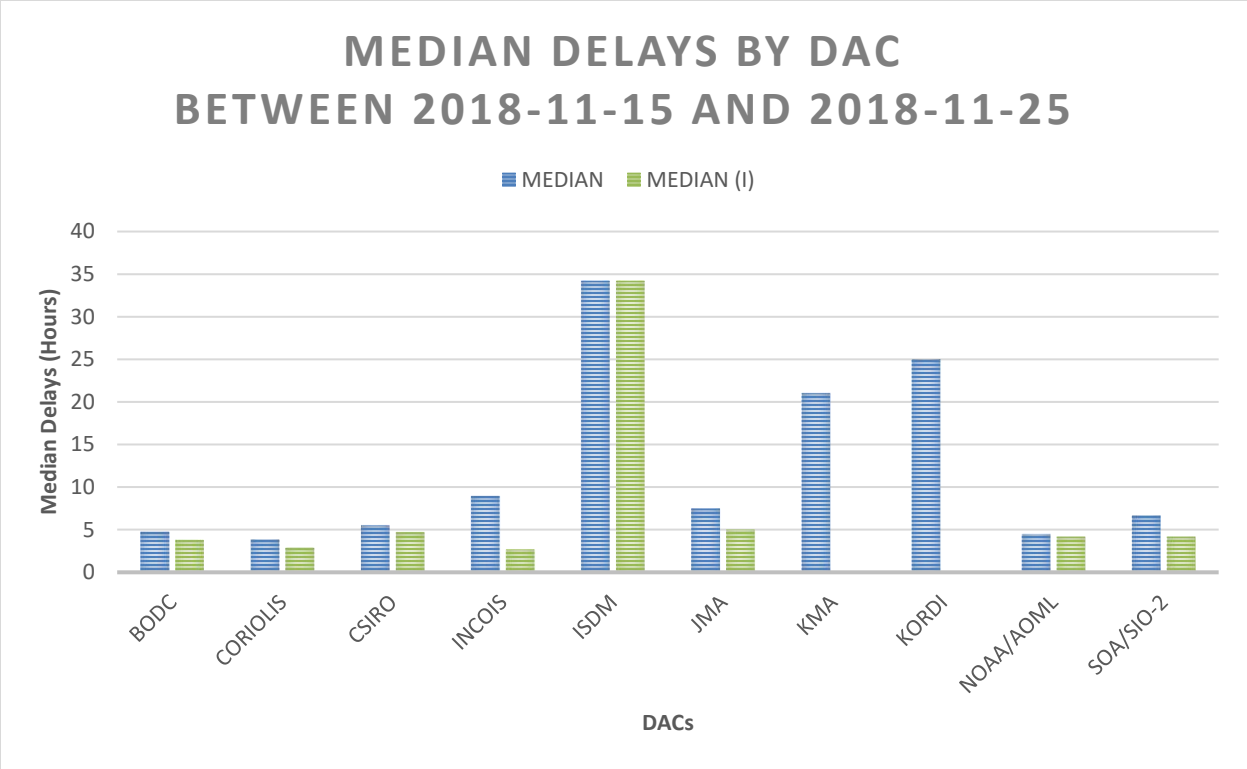


Fig.22: Delays summary table

The same statistics filtered on iridium only floats show no much difference which means that Argos and Iridium floats have no distinct processing, hence we can't get benefit of the substantial reduced surface time with iridium. Some DACs however seem to perform better.

- ⇨ **Recommendation 5:** DACs to review the data processing to make sure that Iridium floats are not slow down by Argos ones and thus optimize the timeliness. Float data should be processed "on the flow" and not at regular batches or at higher frequency (1 hour e.g.).
  A new target of 6 hours might be then easily achieved on the short run.

The delays for BGC floats look very good on the studied time frame, with a median of 3.72hours which means that once processing started, it is flowing properly. A check a year before, shows a median of 6.3h which is very good as well.

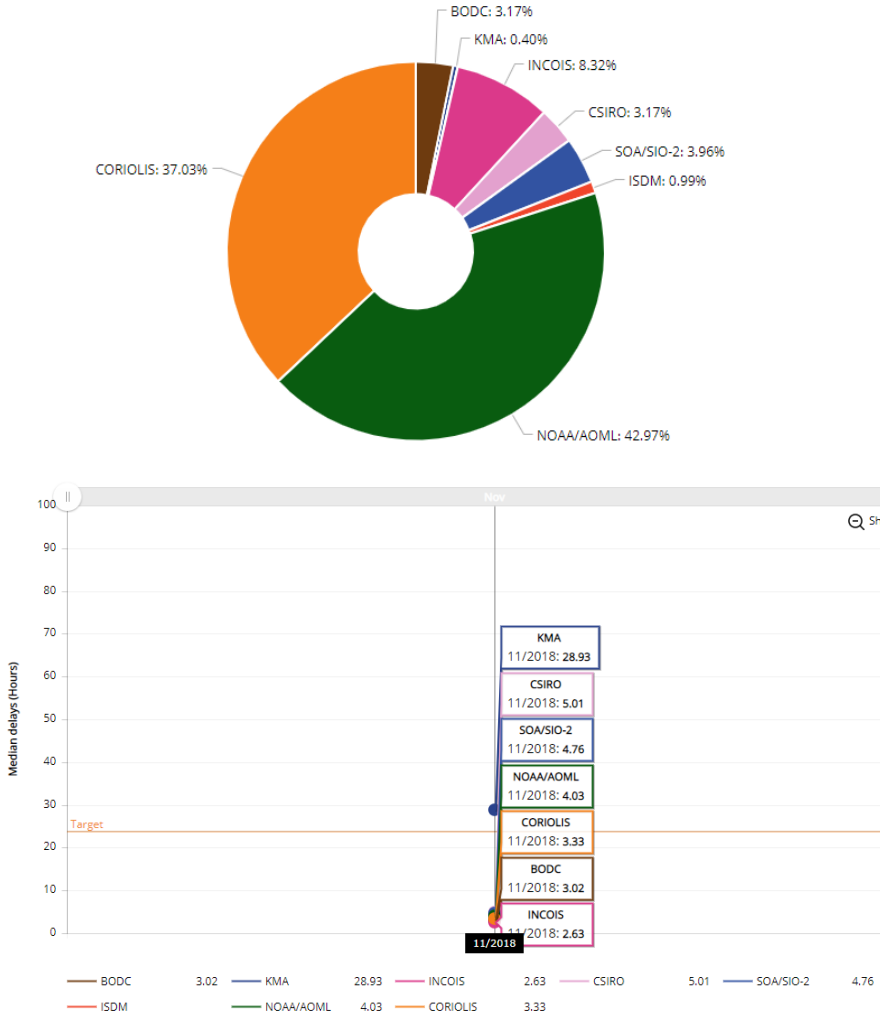


Fig.23, 24: DACs producing BGC data (2018-11-15, 2018-11-25) and delays

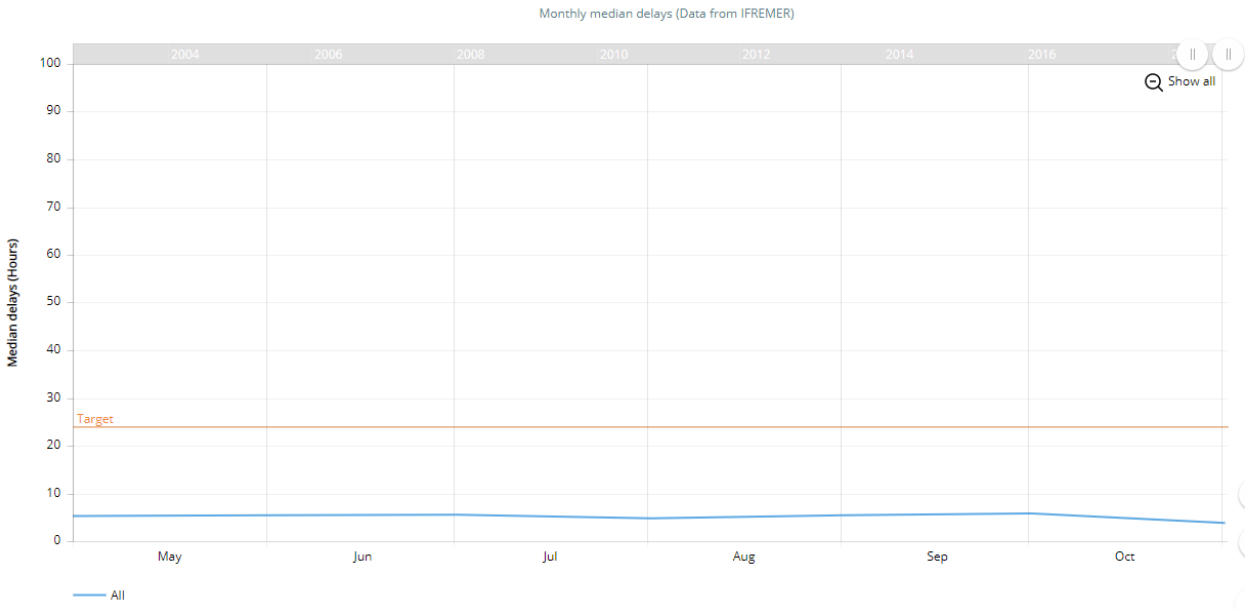


Fig.25: median delays for BGC floats (full time series)

4. Delayed-mode data flow

The quantitative indicator on DM processing (vs DM eligible profiles, i.e. older than 1 year) shows a progress of 5% (vs last year), with 75% of the work achieved by DM operators.
Over the 2 million profiles produced by Argo, 1.4 million were checked by operators.

One DAC doesn't show up any DM profile and I heard it was related to the lack of renaming of profile from 'R' to 'D' so this should be simple to resolve.

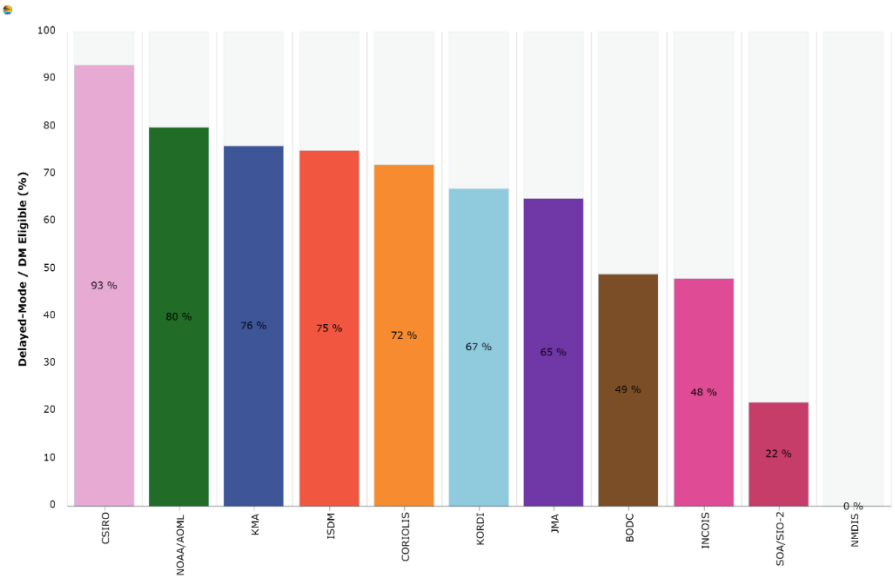
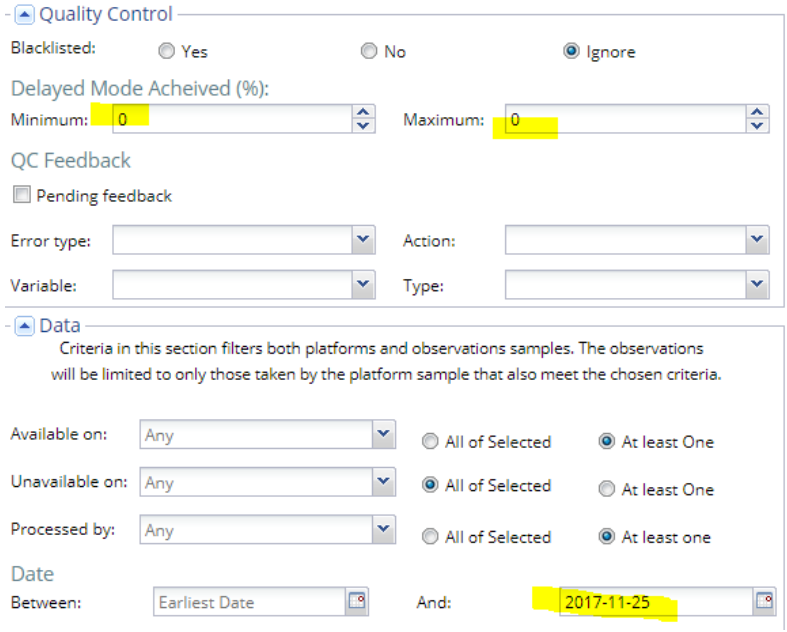


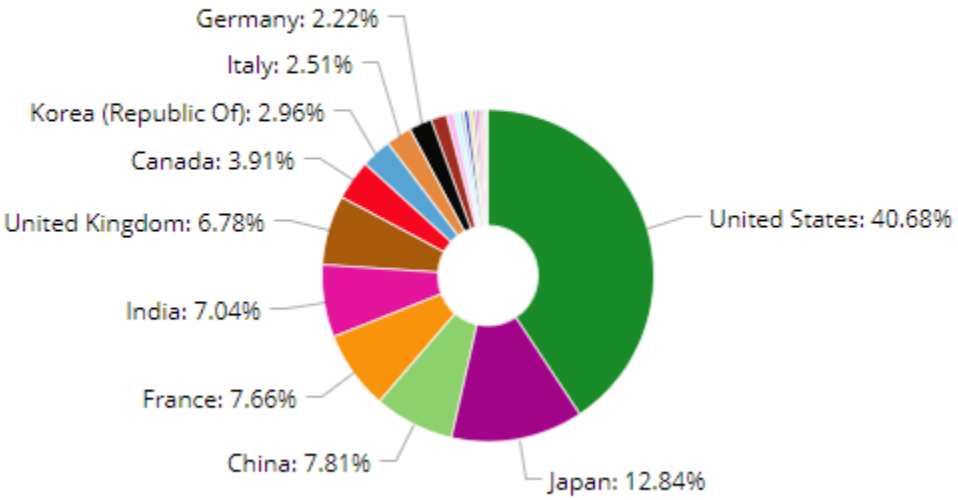
Fig.22: DM processing status by DAC

Orphan floats status

We can check the profiles eligible to DMQC (< 365 days) that have no single DM file available, through the following query:



3380 floats have no DM processing started which represents about 380 000 pending profiles.



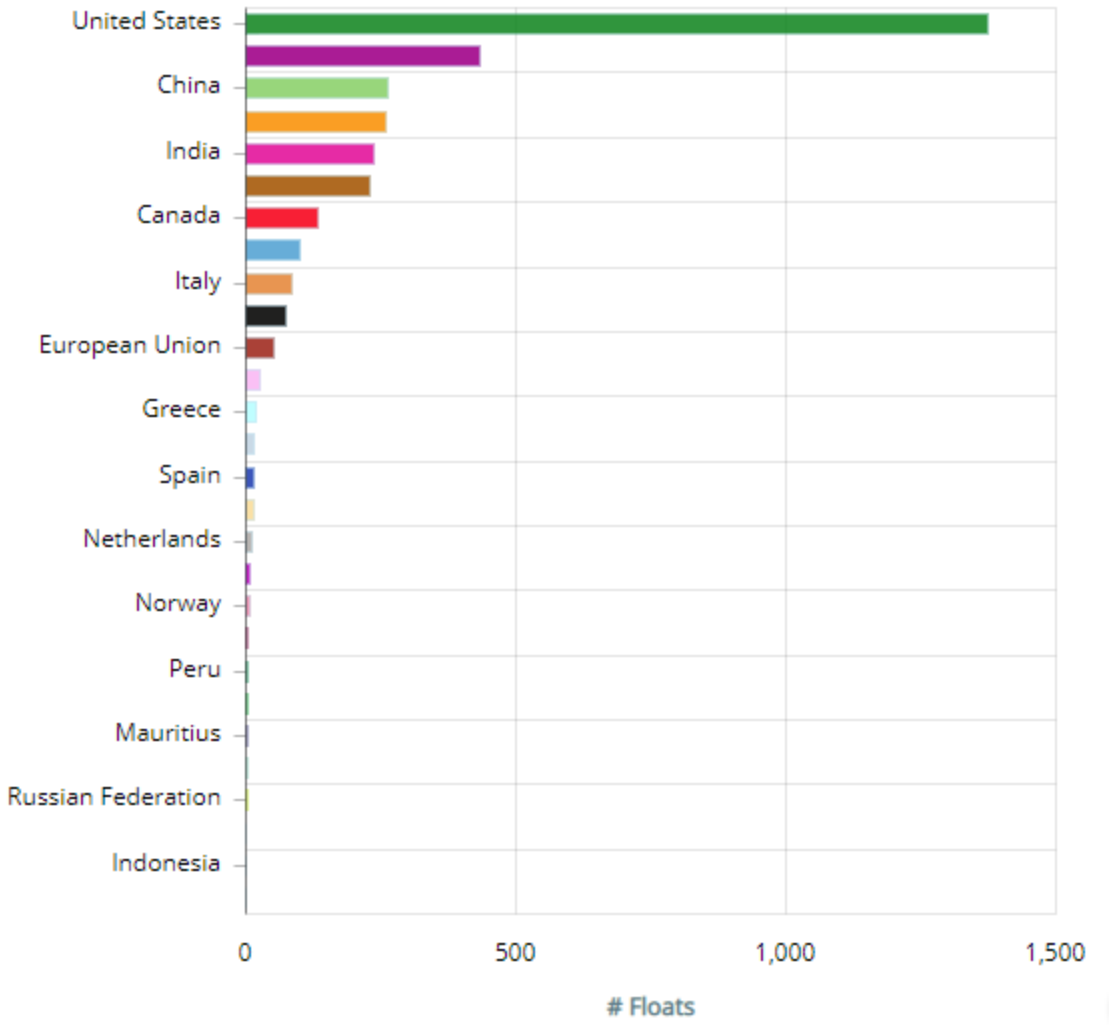


Fig.23,24: Pending floats (no DM QC started), by country (%, and Nb)

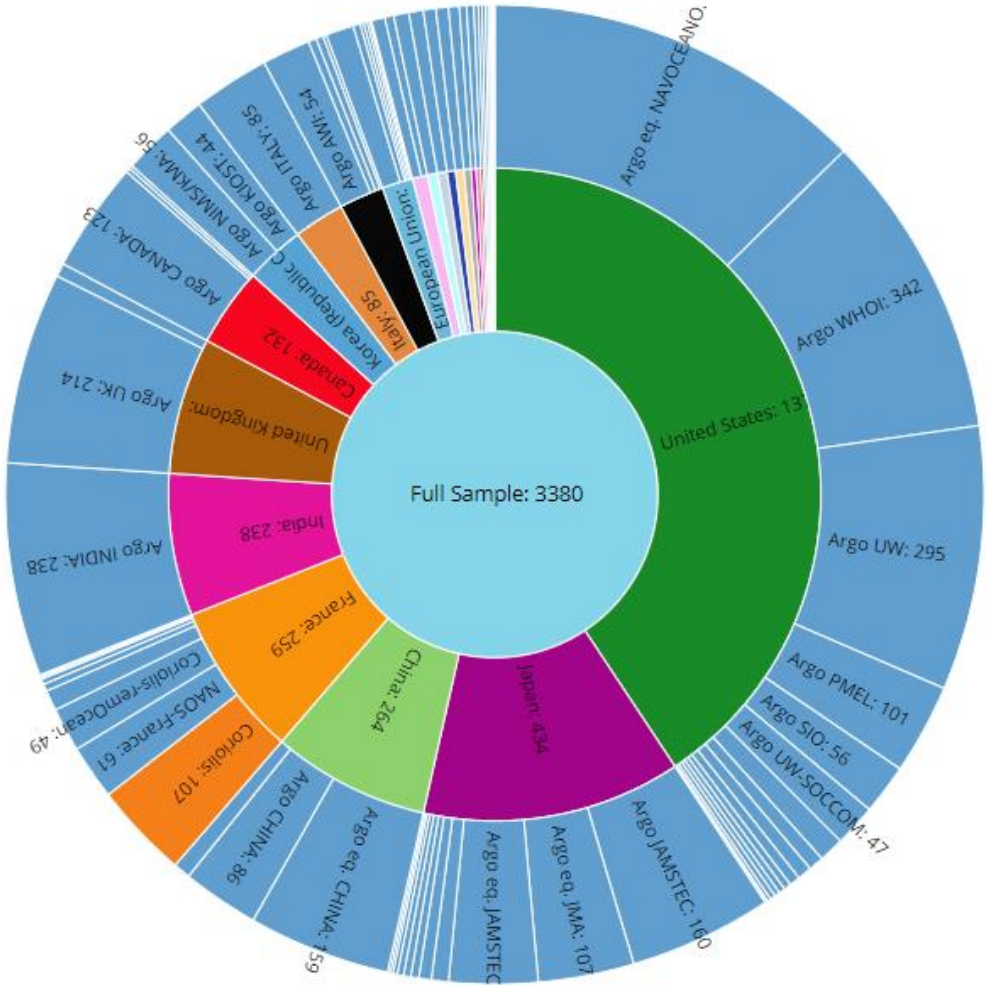


Fig.23: Pending floats (no DM QC started), by country/program

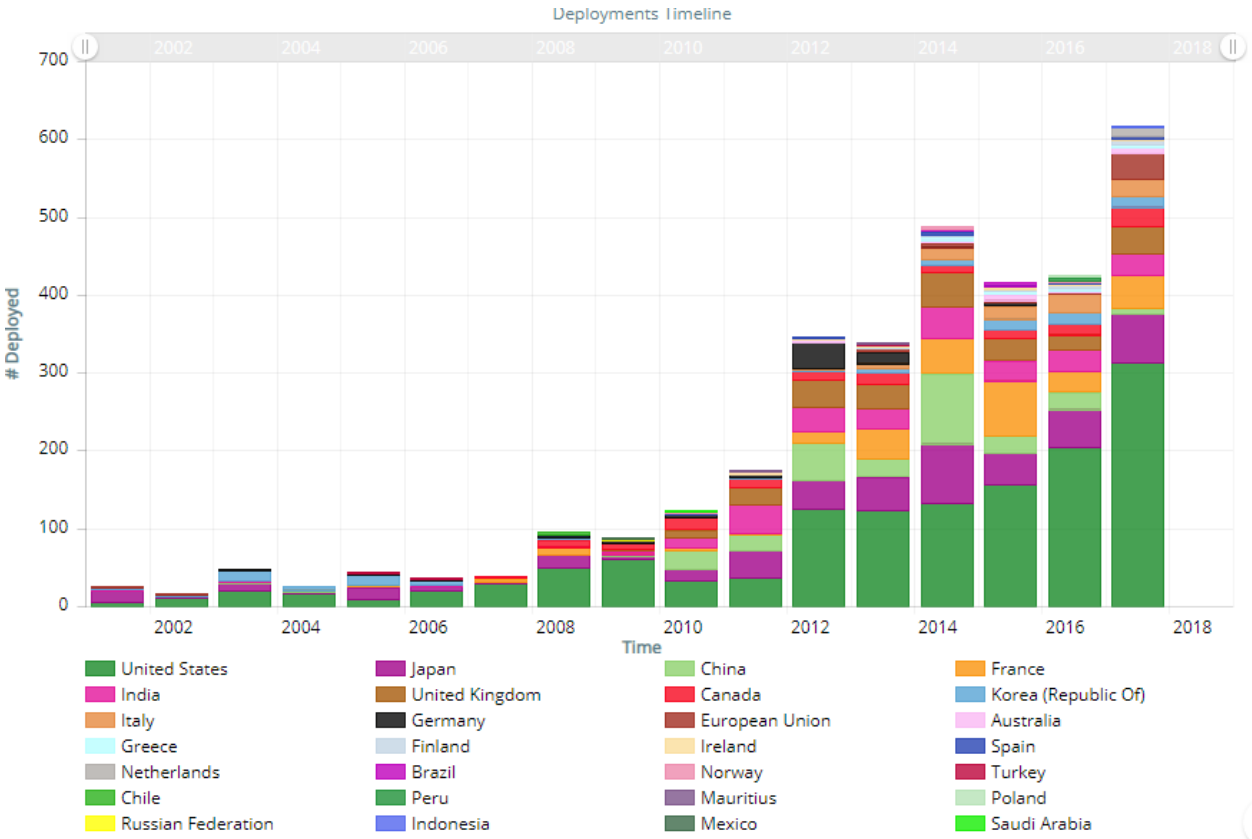


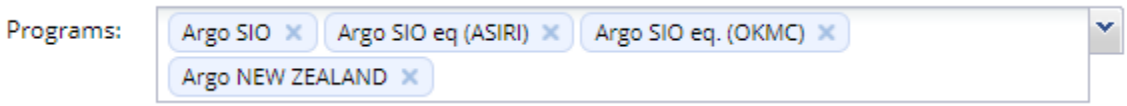
Fig.24: Pending floats (no DM QC started), by country, deployments timeline

How to check pending DM profiles/floats

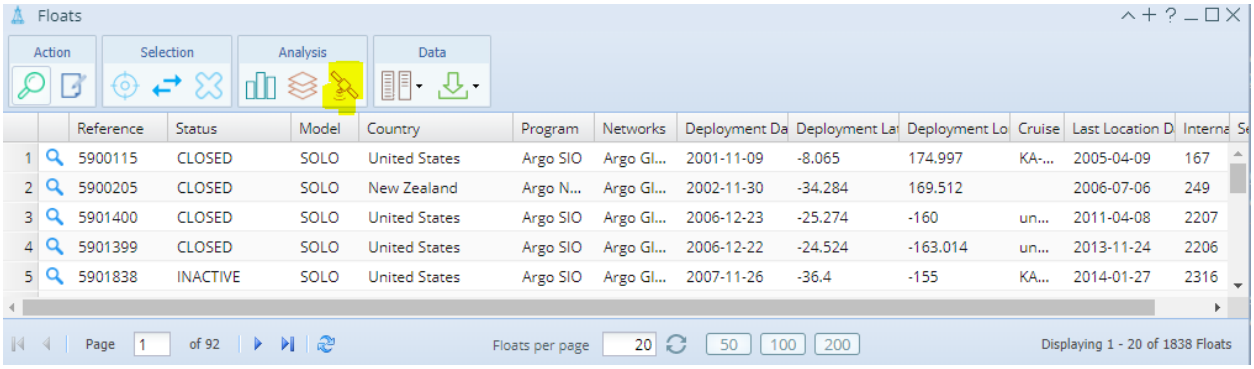
To check pending floats in JCOMMOPS system DM operators can just type their name in the quick search box (bottom left) and check first which programmes are concerned.
Then a search on platforms using the programmes, the data status (real-time profiles e.g.), the observation date, quality control tags (greylist, feedback from Altimetry checks e.g.), PSAL adjustment value, or the ocean basins, can build the list of floats concerned and their profiles (filtered on the criterion as well). The list can be exported in CSV format, including path to data.

Depending on the float/obs sample, the system can be rather overloaded using 2 million records.
We are currently optimizing this part.

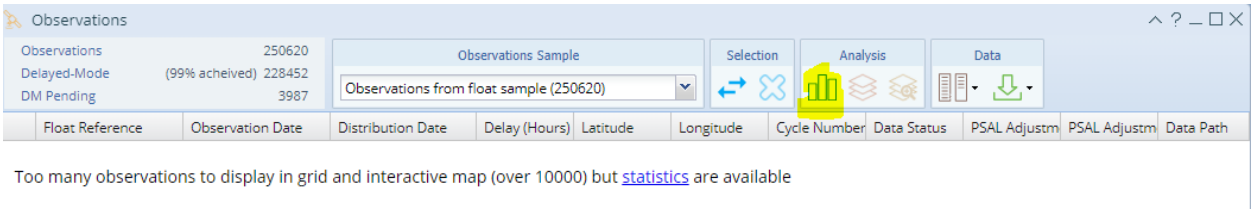
Example: All floats from USA/SIO and New Zealand under the responsibility of one DM operator.



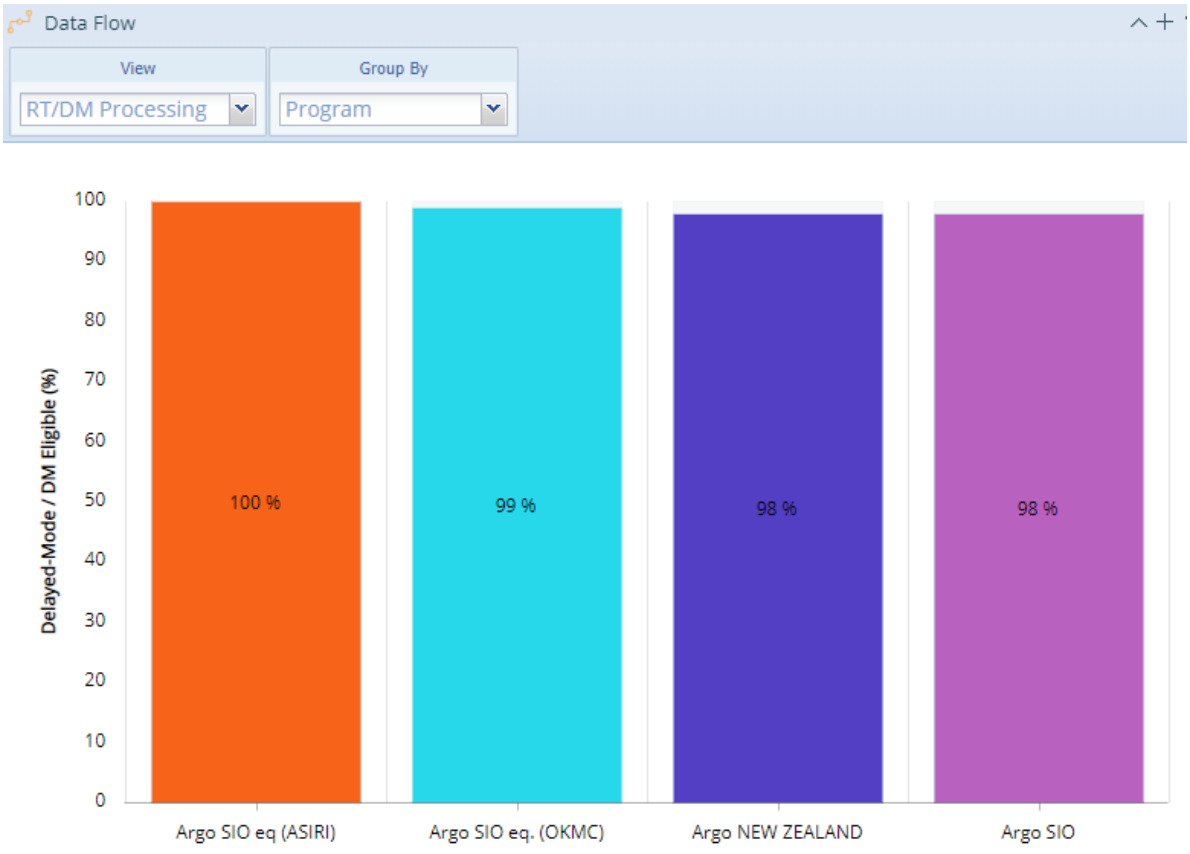
A list of 1838 floats is generated.



A click on “observations icon” highlighted above will open the list of profiles concerned with status of DMQC processing.



A statistics tool highlighted above allows to generate various plots for DM processing, delays, ior PSAL adjustments.



5. QC Feedback

JCOMMOPS maintains a QC feedback relay tool (for all observing systems under its monitoring) which can handle individual feedbacks from users or routine feedbacks such as the Altimetric checks performed by CLS/Coriolis.

The process triggers a standard email to the data producers (DACs and DM operators) with the email subject formatted such as:

`[JCOMMOPS QC] CHK WMO_ID MESSAGE_ISO_DATE`

or

`[JCOMMOPS QC] BLK WMO_ID MESSAGE_ISO_DATE`

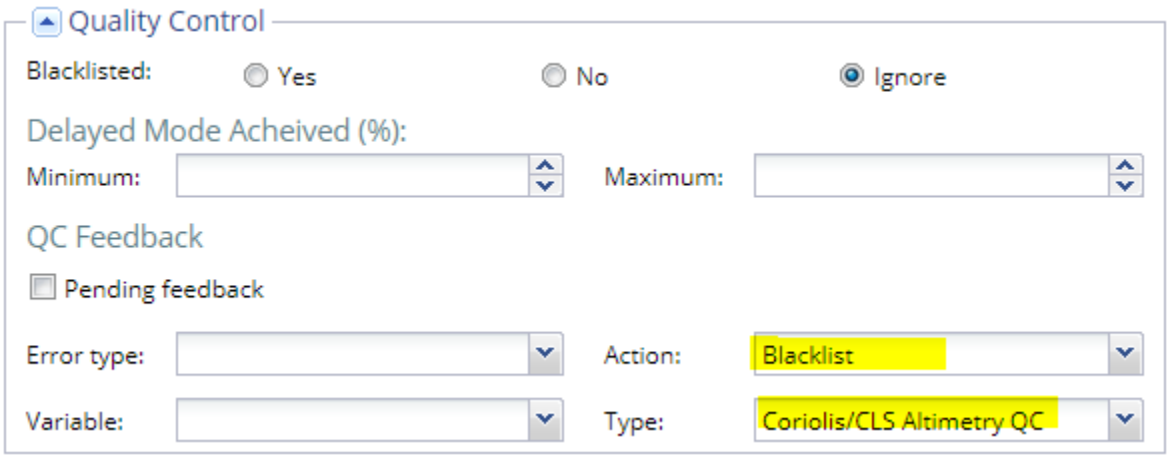
The BLK means that the float targeted by this message needs to be greylisted. This standard email subject could be used routinely by DACs (**action item #9**).

The CHK means that dm operators and DACs should check this float data, potentially feedback through

the link provided to archive the information, and take appropriate steps with DM QC e.g.
If nothing is changed with the data, the next iteration of the Altimetric QC will flag again such float.

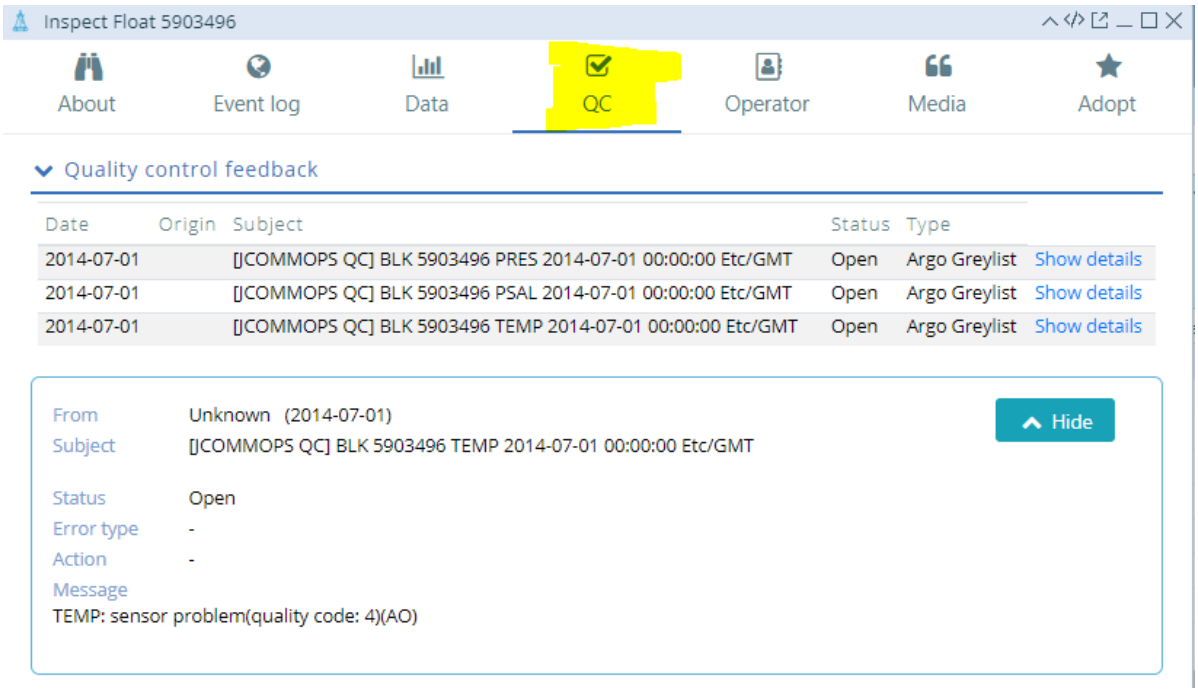
Example:

The search interface allows to generate an appropriate list to check the pending floats.
If we add criterion below to our previous SIO sample, we find 3 floats tagged by the Altimetric QC that have been properly greylisted.



	Reference	Status	Model	Country	Program	Networks	Deployment Da	Deployment Lat	Deployment Lo	Cruise Nam	Last Location D	Internal ID	Serial No.	Blacklisted
	5902364	OPERATIONAL	SOLO_II	United States	Argo SIO	Argo Global, ...	2014-10-01	-41.2	96.5	KAHAR...	2018-11-20	5570	8285	Yes
	3901216	OPERATIONAL	SOLO_II	United States	Argo SIO	Argo Global, ...	2015-05-06	-50.5	-86	NBP15-...	2018-11-18	6265	8378	Yes
	5902398	OPERATIONAL	SOLO_II	United States	Argo SIO	Argo Global, ...	2015-09-21	-36.999	-151.243		2018-11-19		8383	Yes

A search using the “pending feedback” checkbox provides directly the list of floats to be checked.
Details for the QC feedback messages is available in the Float Inspect page:



6. Metadata

Some float operators have suggested JCOMMOPS to develop a netCDF metafile writer/updater.
This is something that could be done.
Overall a better synchronization of JCOMMOPS metadata and Argo meta files is wished.
JCOMMOPS Information System should be migrated soon into the Ifremer network and closer to Coriolis GDAC. This will offer opportunities for machine to machine synchronizations to improve metadata on both hands.

JCOMMOPS is finalizing the development of its API that is based on 5 components:

- GIS API (ESRI engine & API) – operational
- Network specifics (CSV, JSON) for operators and users (push/pull)
- WIGOS compliant XML (to fuel WMO system)
- WMO/WIGOS Id management
- Reference Tables management

Most of the elements of this API will be available and documented by May 2019.
JCOMMOPS will meet with BODC around June 2019 to work on the convergence of the code tables (Networks, seadatanet, WMO, etc).

It is recalled that id the ship name is not a mandatory and standard metadata in the Argo metadata flow, it is in JCOMMOPS. Floats can't be registered and notified without the name of the ship (and ships are unique in JCOMMOPS system with an ICES code).

To conclude this report, we should note that the metadata registration at JCOMMOPS from all Argo programmes (about 50 active) is performed autonomously by "Operations Managers" for 80% of the fleet, rest being done by the Technical Coordinator "on behalf". This is a remarkable cooperation and it also demonstrates some stability of the web interface, which is not yet bug free, but feedback and request for assistance were very rare in 2018.
Argo metadata management is a "golden standard" that all networks wish to achieve.
Thank you all.

On a more general perspective JCOMMOPS is progressing with the metadata quality with all observing networks under its monitoring (Argo, DBCP, OceanSITES, GOSHIP, SOT, OceanGliders, Marine Mammals, HF Radars, SOCONET). All VOS ships have now sensors metadata and unique identifiers, all GOSHIP cruises including WOCE and CLIVAR were registered, all Tropical Moored Buoys and their historical maintenance is registered, and substantial work has started on OceanSITES.

2019 might enable for the first time some cross programme and EOV/ECV based perspective on the observing system. Synergies between the systems will also be captured such as floats deployed along GO-SHIP lines or through VOS ships, or mobile platforms drifting within OceanSITES areas are examples of what an integrated monitoring can provide.