Argo Operational Status AST#18

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Content

Design & Definitions

Design

The new Global Argo design was reviewed and agreed at AST#17 to include in particular Marginal Seas and Polar extensions (Fig. 1).

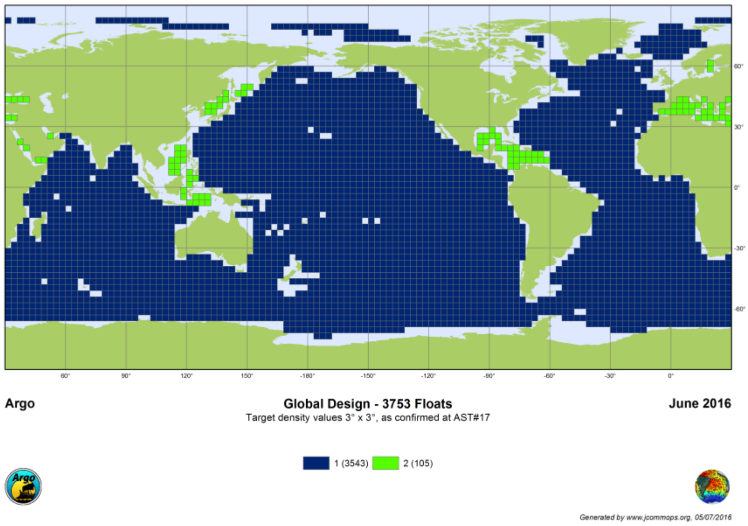


Fig. 1 Global Argo Design for a total of 3753 floats, including a double density in Marginal Seas.

This design agrees with deployment practices. Only 3% of all deployments to date have been made outside of this design and concentrated on coastal areas. A few tens of spots would deserve to be added to the design, in Marginal Seas and coastal areas.

However, the initial design set up for the Southern Ocean (hereafter SO) has used the bathymetry (<2000m) and an average sea ice extent across seasons. If we rather use the multi-year median ice extent for the month of March in particular, we can extend slightly the Argo design and approach the initial numbers calculated by our Australian colleagues (360 units for SO).

To be noted that the Ross Sea is open In February.

About 50 grid elements could be added to the SO design.

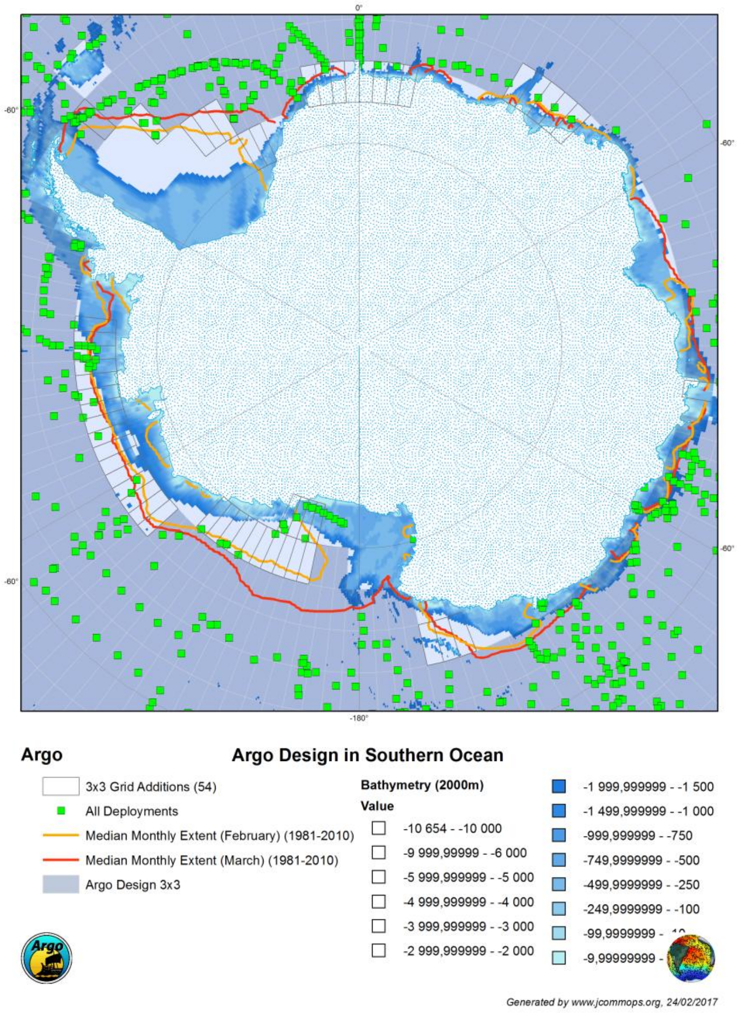


Fig. 2: Argo Design in Southern Ocean

Fig. 2 shows the potential additional elements (white rectangles) matching with the appropriate bathymetry (blue palette shows the bathymetry shallower then 2000m), practices (green square show all float deployments to date), and median sea ice extent in February and March.

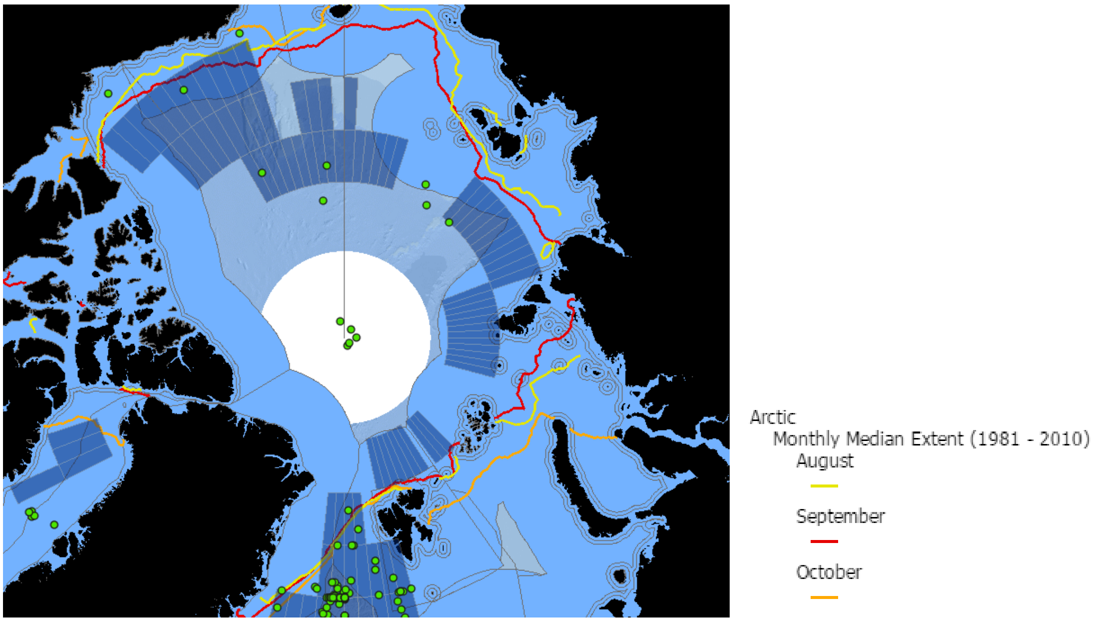


Fig. 3: Argo Design in Arctic Ocean

Similarly we should review the design in the Arctic Ocean (Fig.3), and considering that a large part of this oceanic region is covered by sea ice all year long, and in Exclusive Economic Zones (EEZ). Rare observations have been made rather through POPS systems than regular profiling floats. There are actually no more data coverage outside the Norwegian basin. 70 grid elements are covered by ice throughout the year.

- ⇨ **Recommendation 1:** Review and feedback on the design for the Southern Ocean.
- ⇨ **Recommendation 2:** Potentially remove most of the central part of the Arctic Ocean

As new community requirements will be refined over the next years, a sketch design is also considered, to dimension the cost in extras floats and start the monitoring of proposed extensions. It is suggested to call such design "Argo 2020" in line with a number of regional initiatives such as Tropical Pacific Observing System (hereafter TPOS) 2020 or AtlantOS, and OceanObs'19 that should participate in defining new targets for our array around 2020.

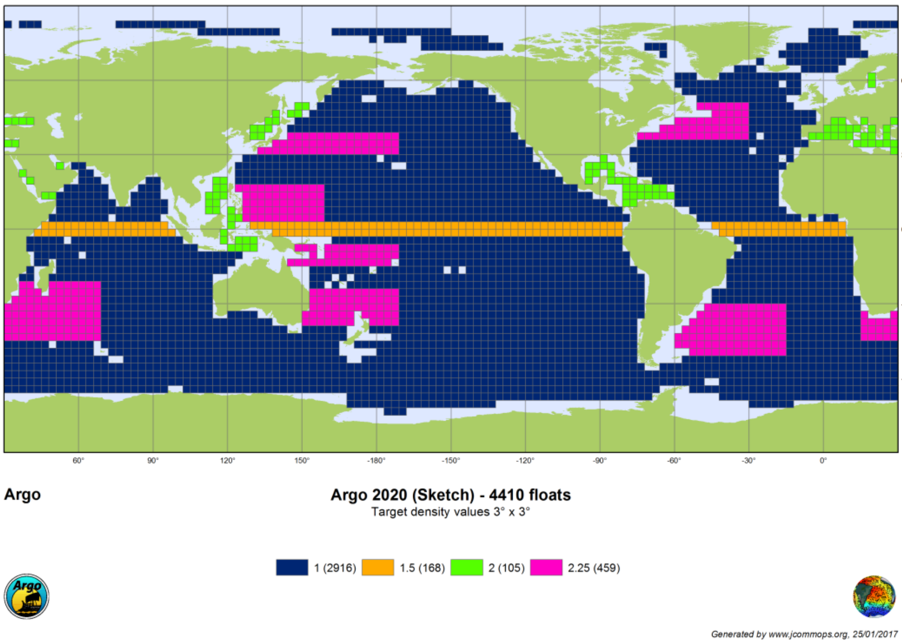


Fig. 4: Argo 2020 Design for a total of 4410 floats, including an increased density in Equatorial regions (x 1.5) and in Western Boundary Currents (x2.25)

The TPOS 2020 report brings new requirements for the future Argo design:

Action 2
Argo deployments should immediately be doubled equatorward of 10° in the west (especially outside the TMA-occupied region) to maintain subsurface temperature and salinity sampling and compensate for the declining TMA.

Action 3
Argo float deployments should be doubled over the entire tropical region 10°S-10°N, and return increased upper ocean vertical resolution.

The increase would be staged as follows:

1. The western Pacific (see section 7.4.2).
2. The eastern Pacific, to pick up sharper meridional gradients in temperature and salinity.
3. The trade wind regions (beyond 2°S/2°N) in the central Pacific (approximately 165°E to 125°W), partly to meet additional requirements and partly to enable evolution of the TMA.
4. Finally, the entire tropical region.

In the TPOS area we have 3 different target density values for Argo design, see (Fig. 5): 1.5 (orange), 2.25 (pink), and 2 proposed for the -10°S/10°N band.
How do we combine these requirements? The numbers provided further in this report consider a density = 2 where density <2, in the -9°/9° band.

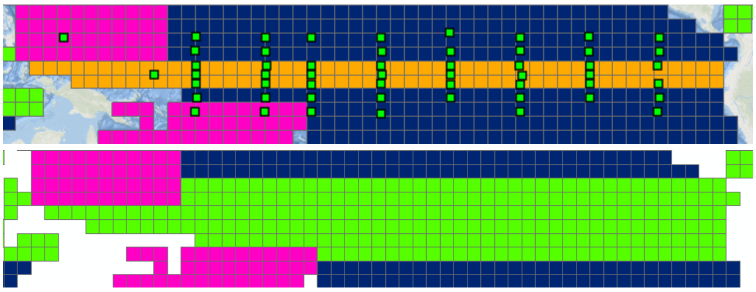


Fig. 5: Existing and proposed targets for TPOS region,
TAO/TRITON operational moorings as of January 2017.

⇨ **Recommendation 3:** Confirm and include TPOS2020 requirements in Argo 2020 Design.

The TPOS2020 region where it is recommended to double the density represents an extra contribution of 96 floats per year to reach the proposed design by 2020 (see Table 1).
It is to be noted that half of such region have seen none or once deployment over last 15 years. Most of the deployments were concentrated around the Tropical Atmosphere Ocean array (TAO) region (Fig. 12).
Such density expansion will need a strong additional contribution in floats from existing partners (mainly USA, Japan and China, see Fig. 6, 7). These deployment activities certainly imply as well dedicated ship time through *e.g.* chartering. If we keep the existing distribution of float providers in TPOS, the TPOS2020 extension will require: 60 extras floats per year for USA, 15 from Japan, 10 from China and couple of extras floats from France and Australia.

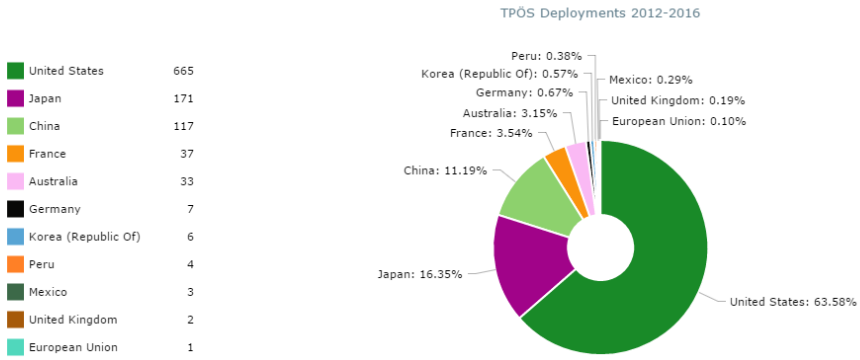


Fig. 6: TPOS region implementers (2012-2016)

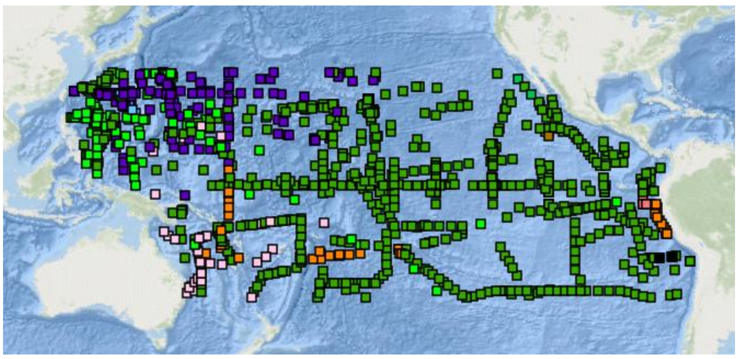


Fig. 7: TPOS region - map of deployment locations (2012-2016)

Networks

Networks are defined as follow:

Argo Core:	float funded under Argo national program (without BGC sensors, not deep)
Argo Equivalent:	float not funded under Argo (without BGC sensors, not deep)
Argo BGC:	any float with any BGC sensor
Argo Deep:	any deep float

Argo Global = Argo Core + Argo Equivalent + Argo BGC + Argo Deep

Except for Argo Global, all networks are exclusive.
A number of floats such as deep floats sampling on descent and transmitting profile after 30 days at ascent, or other floats with different sampling schemes are excluded from "Global Argo". So this has to be defined in details.

It is important to make a clear distinction between core floats and other as we have less means of coordination and guidance for the others.

- ⇨ **Recommendation 4:** define the floats sampling strategies that can or cannot be included in Argo Global

- ⇨ **Action 2:** (JCOMMOPS) to review the list of equivalent and BGC programmes with AST members.

At the time of writing this report (Feb. 2017), on the 3988 operational units, 3406 are core Argo floats. But this number is certainly underestimated as some regular Argo programmes are used to test BGC sensors and oxygen in particular.

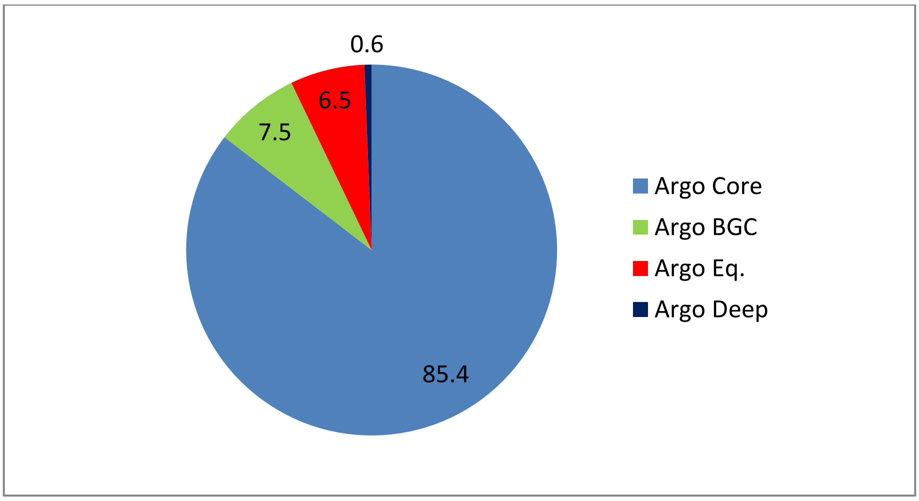


Fig. 8 Distribution of floats by network (%)

Basins

Ocean basins are defined as in Fig. 9:

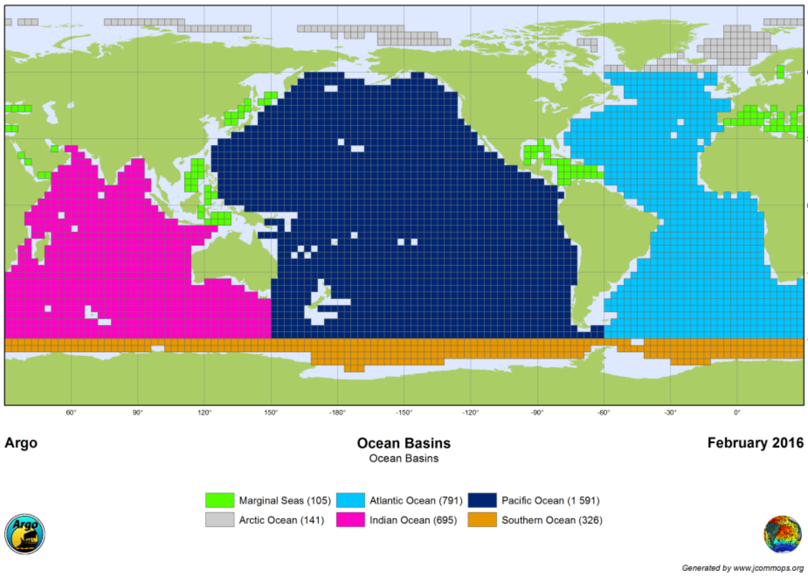


Fig. 9 Basin boundaries used for performance Indicators calculations

Further in this report we will split Atlantic and Indian Ocean in 2 sectors by the equator, and Pacific Ocean by the equator and -150°W longitude.

Performance Indicators

Amongst the 120 indicators developed for Argo so far, 3 set of indicators are calculated routinely (monthly, or yearly) to monitor the program implementation: Activity, Intensity and Coverage. These indicators are available for different networks and basins and different sub-networks or extensions (Marginal Seas, TPOS, AtlantOS, Western Boundary Currents (WBC), Equatorial (Eq.)).

All these indicators are not trying to encourage a perfect implementation of the array but their time series allows detecting trends and gaps.

Another set of indicators is calculated for the Argo2020 design extension areas (WBC, Eq.) as the targets are different.

Activity: number of operational units (distributing data at GDACs within 30 days, or 365 days if iced over) in the design versus target (monthly calculation).

Coverage: These indicators provide an idea of the spatial distribution of the array from the observations distributed.

Coverage Yearly: For a given calendar year, we calculate the average number of observations distributed in a grid element each month. Then we calculate the number of grid elements in our design that are well sampled, i.e. having the number of expected observations (3, or 6 in marginal seas), versus the total.

Coverage Monthly: same calculation without doing an average on the year

Coverage Monthly/Sum: To the calculation above, we add the fraction of grid elements that are not fully sampled.

The targets used for these calculations are all based on 10 days cycles. If some areas require 5 days cycles (*e.g.* Marginal Seas), then we need to adapt the calculation.

Monthly or yearly Coverage maps are available on the website through the static map viewer and in the interactive map. The monthly map is also available in a second view, normalized on the Argo 2020 design.

Intensity: number of units deployed in the last 12 months in the design vs target (monthly calculation). The target is defined by dividing the activity target by 4.1 (150 10-days cycles). This value is very close from the calculated life expectancy (3.99 for 2016) for the global array, but not for the Mediterranean Sea.
Given as well that the mortality rate is twice higher in the Mediterranean Sea the target should be doubled.
This higher mortality rate is certainly due to the higher profiling frequency.
The Southern Ocean float life expectancy has improved to the Argo average but as some floats remain "operational" for a year when iced over, we need to wait the year after to have a good idea of the mortality rate for the considered year. Southern and Arctic oceans mortality rate is probably slightly higher than for Argo. Find more information in the annex "Instrumentation".

Mortality Rate Argo Global	25.58% 2016
Mortality Rate Argo Global - Southern Ocean	25% 2016
Mortality Rate Argo Global - Indian Ocean	22.21% 2016
Mortality Rate Argo Global - Arctic Ocean	35.39% 2016
Mortality Rate Argo Global - Atlantic Ocean	26.01% 2016
Mortality Rate Argo Global - Mediterranean Sea	48.1% 2016
Mortality Rate Argo Global - Pacific Ocean	24.12% 2016

Fig. 10: 2016 Mortality Rate for Global Argo and by basin.

⇨ **Recommendation 5:** Monitor the mortality rate in other Marginal Seas. Double the intensity target in Mediterranean Sea (14 to 28 deployment per year) and potentially in all Marginal Seas.

Density Maps

Density maps count the platforms operating rather than observations distributed as for coverage maps. Density maps are built on 6°x6° grid to facilitate deployment planning.

The density target of each grid element was updated to include the sum of the targets of underlying 3x3 elements. In other words when a 6x6 element include only one 3X3 element (*e.g.* in coastal areas), the target is 1, not 4.

These maps are available monthly in the static map viewer, and in real-time in the interactive map, through 4 versions:

- Density: Number of operating floats vs target
- Density/Age: Number of operating floats, weighted by their probability to survive one year, vs target
- Density/Plan: Number of operating floats, weighted by their probability to survive one year, plus deployment plans, vs target
- Density/Plan (Gaps): same as above, but all elements where density≥target are transparent, so we can clearly highlight the gaps.

Extras layers are available in the interactive map with normalization on Argo 2020 targets for those interested in implementing extensions areas.

Targets

Here are the different targets we computed for the activity and intensity indicators presented earlier (Table 1).

The coverage target or "good performance" indicator in a traffic light style dashboard is difficult to set given the dynamic nature of the global array. A coverage target of 75% is chosen for now and may be too challenging to reach and sustain. We will see further in this reports that some sub basins have reached 80% coverage anyway. Selecting appropriate KPIs and targets is important for communicating on the performance of Argo. Choosing 70% will turn green the KPIs for main basins.

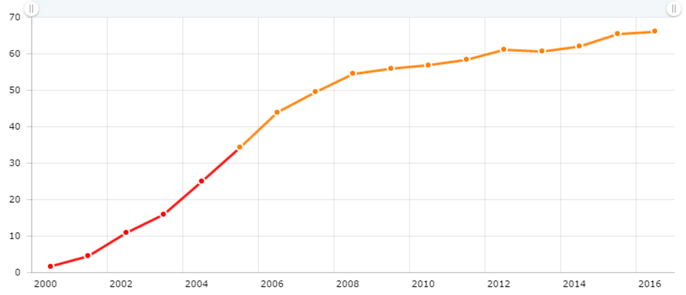


Fig. 11: Evolution of yearly coverage indicator for Argo Global (%, Y axis) over last 16 years (X axis). At which % do we turn the graph green?

⇨ **Recommendation 6:** Decide which target is appropriate for the coverage indicator (communication and cosmetic issue).

The Table 1 below summarizes all targets for our current Global Design and for its potential modifications in high latitudes and marginal seas (*). A second view provides the targets for the Argo 2020 sketch design, including Equatorial and WBC enhancements. A third view provides the targets including in addition the TPOS 2020 recommended enhancements. The "extra intensity" of floats (vs Global Design) required yearly to implement these enhancements is provided.

	Argo Global Design		**Argo (2020)**			**New Argo (2020)**		
	Activity	Intensity	Activity	Intensity	Extra	Activity	Intensity	Extra
Global Argo	**3753 (3773)**	913 (959)*	**4410**	1073	160	**4609**	1173	260
Atlantic Ocean	791	192	1007	245	53	1007	245	53
Indian Ocean	695	169	833	203	34	833	203	34
Pacific Ocean	1590	387	1894	461	74	2092	509	122
Southern Ocean	326 (+50)*	79 (+12)*	326	79	0	326	79	0
Arctic Ocean	141 (-70) *	34 (-17) *	141	34	0	141	34	0
Marginal Seas	210	51 (+51)*	210	51	0	210	51	0
TPOS [-30°;30°]	892	217	1088	265	48	1286	313	96
WBC	459	112	1033	251	139	1033	251	139
EQ.	168	41	252	61	20	300	73	48

Table 1 Activity/Intensity Performance Indicator Targets

⇨ **Recommendation 7:** Confirm "Argo Global" and "Argo 2020" designs.

⇨ **Action 1:** (JCOMMOPS): update the "Global Argo" and "Argo 2020" designs accordingly, and recalculate all concerned targets and performance indicators.

History & Practices

The Argo design can be used to analyze the practices over last decade. The following figures (12, 13) show the density of deployments since 2000. The Southern Ocean (oceanic region below 60°S) was not officially in the Argo design until last year so we can't really conclude that it is a challenging zone, even if it seems obvious. The -30°S/-60°S band is challenging anyway. The Equatorial Pacific seems heavily dependent on TAO array maintenance. Surprisingly, there is a small gap in North Atlantic at (30W, 39N) and as well as the central North East Pacific.

Finally a number of coastal regions (*e.g.* Arabian Sea, Bay of Bengal and Labrador Basin) seem frequently occupied due probably to the use of routine logistics means, and additional equivalent or BGC contributions. These areas are indicating a high interest from implementers, closer from national research priorities and expertise domains.

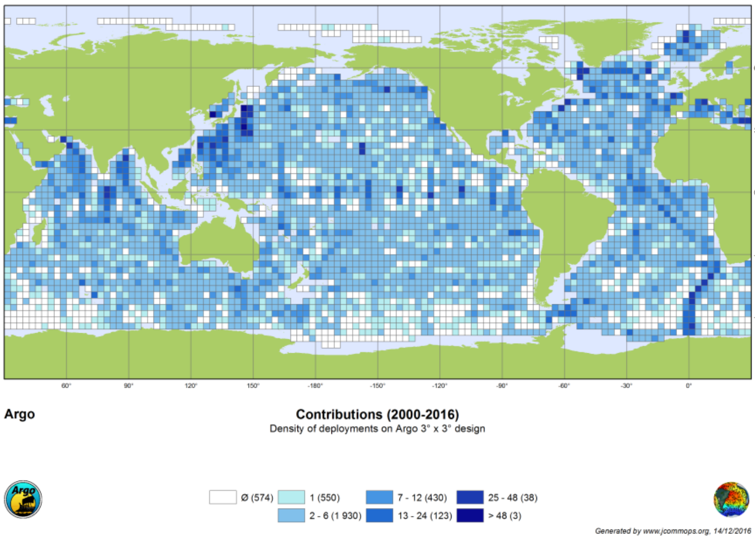


Fig. 12: Density of deployments 2000-2016

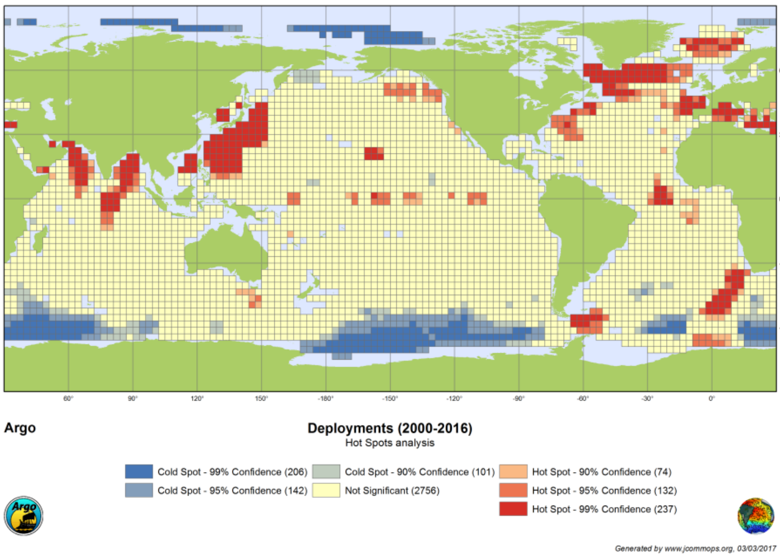


Fig. 12, 13: hot spots analysis for 2012-206 deployments

The hotspots analysis reveals further the gaps in our ship time capacity and highlights routine deployment areas. Beyond the Aghulas/Good Hope, Polarstern, and Hobart, there are no other routine logistic means for the Southern Ocean.

PIRATA and TAO array maintenance seems to be well used, but RAMA not much.

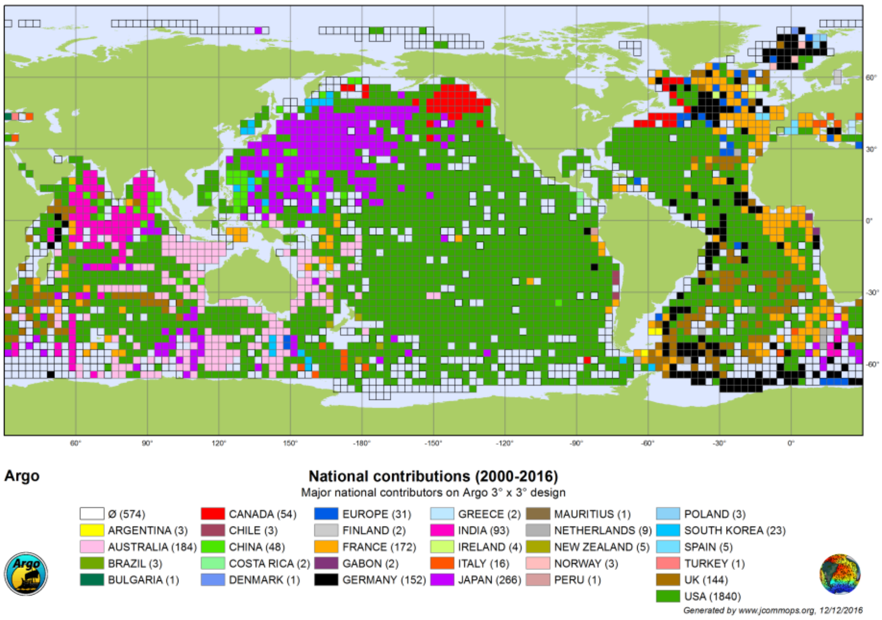


Fig. 14: Major national contributions 2000-2016.

As seen on Fig. 14, Argo implementation is an aggregation of national contributions which is working rather well.

We study below the last 5 years of implementation to potentially detect some misbalances in national program capacity and practices, and analyze the sustainability of each basin.

But firstly, we need to check if Argo is sustainable through its national regular or “core” programmes.

	TOTAL	**AO**	**IO**	**PO**	**SO**	**Ar**	**Marginal**	**Other**
Argo Core	3520	995	606	1363	176	80	198	102
Other	1239	172	237	446	42	38	191	111
TOTAL	4759	1167	843	1809	218	118	389	213
TARGET/year	**913**	**192**	**169**	**387**	**79**	**34**	**51**	
avg(year) core	704	198	121	273	37	16	39	
DIFF core Nb	-209	6	-48	-114	-42	-18	-12	
Diff. core %	**-23**	**3**	**-28**	**-29**	**-53**	**-53**	**-23**	
avg(year) total	952	234	169	362	46	24	78	
DIFF total Nb	39	42	0	-25	-33	-10	26	

Table 2: Deployments 2012-2016, by ocean basin

The Table 2 shows first that core Argo is underfunded by 23% each year. However, extras contributions could cover this deficit.

The Atlantic Ocean is the only basin that can be sustained without extra contributions from research or other projects. Indian and Pacific Oceans are ~30 % underfunded, Southern Ocean ~50%.

If we consider all contributions, practices over last 5 years (2012-2016) show a misbalance in the Atlantic Ocean with an excess of 42 floats per year on average. Indian Ocean is fine; Pacific Ocean lacks 25 units per year.

Other basins were not part of the design for the last 5 years, so conclusions would not be fair at this point. Anyway, Marginal Seas seem to have insufficient resources beyond equivalent contributions, and polar extensions need to increase the yearly effort.

Further in this report the Table 9 provides the same statistics with national contributions. USA, France, Germany, UK and Canada are the main implementers for the Atlantic Ocean. Coordination should be improved to optimize deployments and potentially address challenges outside the Atlantic Ocean. This will be facilitated through the new EuroArgo infrastructure.

We had in the past some regional working groups to prepare implementation plans for the different basins. It would be good to reactivate those groups (see annex for implementers list by basin) to draft and confirm the planning, and share key deployment opportunities.

- ⇨ **Recommendation 7:** Improve the coordination concerning the deployment planning between Core, Equivalent and BGC Argo as far as possible, to avoid overlaps.
- ⇨ **Recommendation 8:** Improve the regional coordination and planning for the Atlantic Ocean between EuroArgo, USA and Canada.
- ⇨ **Recommendation 9:** Improve communication at the basin level for implementation plans through working groups and teleconferences.

The deployment hot spots deserve further investigations. Is there any interest to routinely implement these regions and take benefit of the spatial dispersion of the floats?
Figure 15 shows launch locations (blue dots) in the Atlantic, of all floats that produced observations in the Indian Ocean (latest location color coded by age). Floats deployed in the South East Atlantic Ocean contribute to gather observations in the Indian Ocean, however, east of 60°E the floats are likely finishing their operations. Since 2012, 66 floats deployed in the Atlantic Ocean have contributed to the South West Indian Ocean array. In other words, the contribution of the Atlantic Ocean deployments to the Indian Ocean is real but rather limited to a dozen of floats per year. The phenomenon is marginal for the other hot spots, floats stay roughly in the area in which they were deployed. An accumulation of deployments will not contribute beyond the region sampled.
Others deployment hot spots seeded regions are either Marginal Seas or WBC which require higher float density.

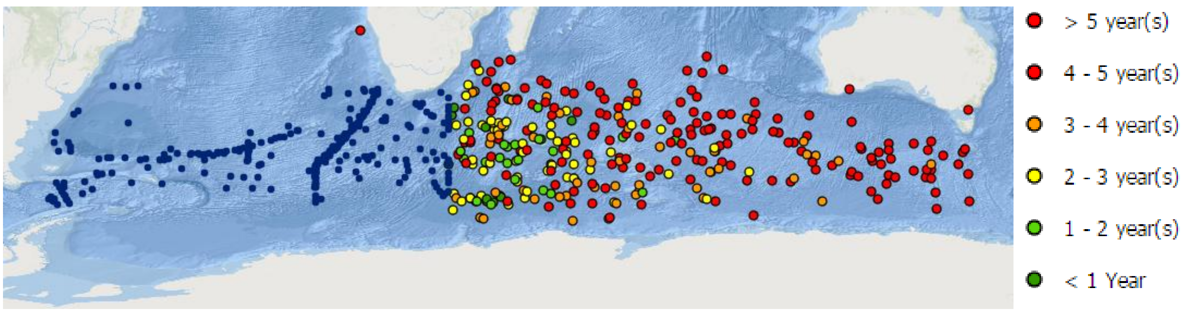


Fig. 15: Drift of floats from a deployment hot spot

It would be interesting to map the residence time of floats for these areas. It might help us to refine the targets and potentially recommend a higher deployment rate in where the floats dynamic may be higher than usual.

One of the critical and regular balance mechanism for the global array maintenance is the use of the R/V Kaharoa funded through US/NZ/AU cooperation (Fig. 16). This is a clear choice from implementers to deploy less float but in a specific place to increment the global coverage. With an average of 110 deployments per year over last 5 years, alternatively deployed in Indian and Pacific Ocean, the Kaharoa is vital to the global array.
Any difficulty of funding or operating that capacity will definitely impact the Argo program; some backup solution could be investigated to sustain Argo on the long run.

Last year main recommendation was to deploy about 200 units in Indian Ocean. In 2016 253 floats were effectively deployed in the Indian Ocean. However we can notice (Fig. 17) that some float deployments are accumulated along routine opportunities without impacting the overall quality of the Argo spatial distribution (vs requirements).

- ⇨ **Recommendation 10:** Increase cooperation around charted based deployment opportunities. One extra yearly cruise could be set to complete Karahoa's contribution and prepare the future.

We note finally (Fig. 18, 19) a light decreasing trend for the yearly deployments. 2016, with only 883 deployments has not been a very good year for Argo. The ratio "extras vs core" remain stable, at around 20% (Fig. 19).

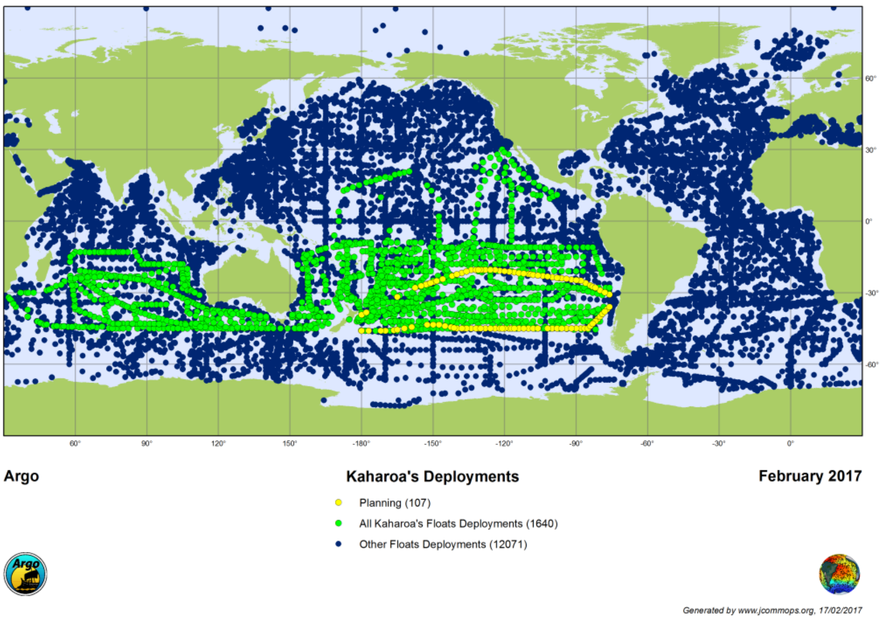


Fig. 16: History of Kaharoa deployments and 2017 Planning.

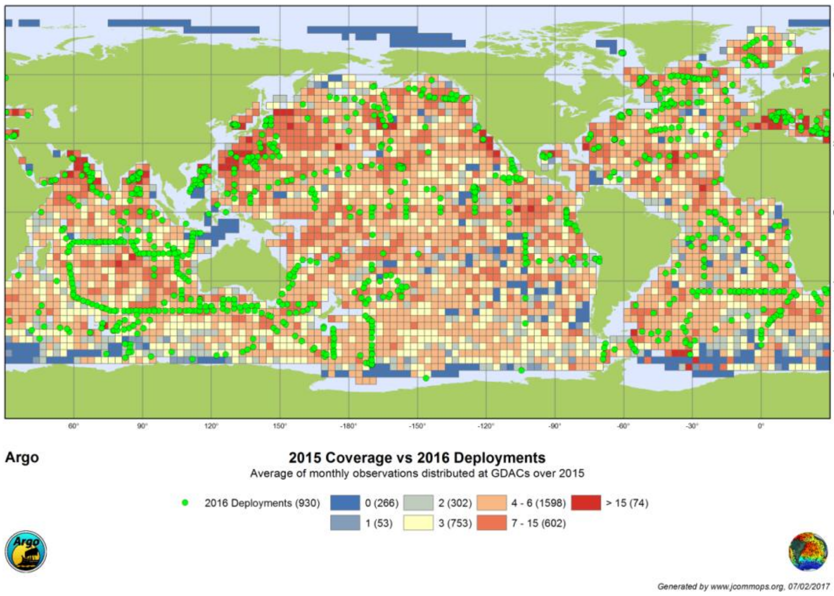


Fig. 17: 2015 coverage status (colored squares) and 2016 deployments (green dots).

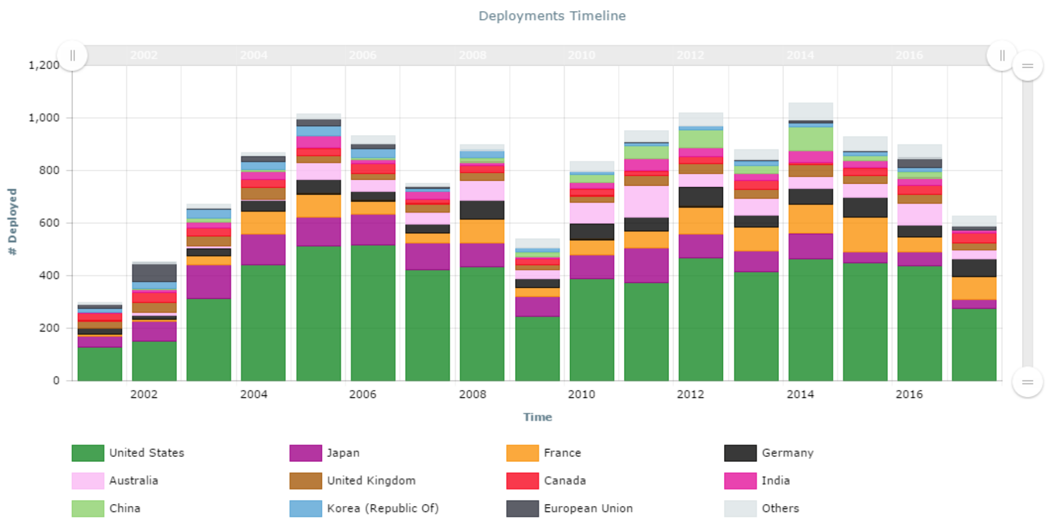


Fig. 18, 19: Argo yearly deployments by country, and with the share of "extras" (equivalent, BGC, deep) contributions

Implementation Status

Activity

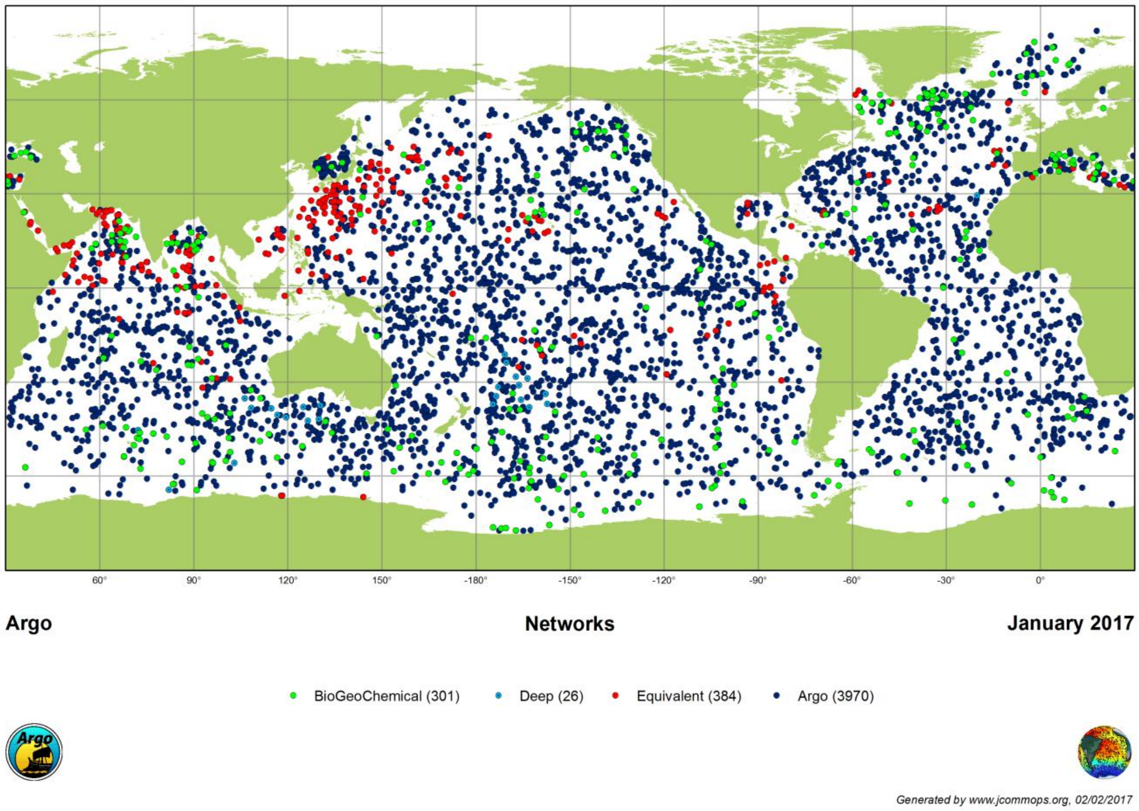


Fig. 20: Argo operational networks

The global array has an appropriate number of operating units to maintain the latest design. Actually we have now more floats than ever and we may pass the 4000 units milestone by the time of next AST meeting. But this is made available through the additional 15% of equivalent and BGC contributions. We can see that the hot spots in North Atlantic, North Indian, and North West Pacific oceans are due these extra contributions (Fig. 20).

Regular national Argo budgets are therefore insufficient to complete the design and the Core Argo activity is short by 10%. No much cooperation can be yet anticipated with equivalent and BGC Argo contributions that are addressing regional requirements and pilot projects. So either national programmes increase their budget, which is uncertain, or either they increase their cooperation with BGC Argo and research initiatives. In any case, an optimization of resources available is critical and new partners should be encouraged. Extras contributions to Argo are also invited to check the global network status and avoid unnecessary overlap.

- ⇨ **Recommendation 11:** Seek new national contributions, new partners and communicate on this need (ideally 200 floats per year are required: 100 for Pacific Ocean, 50 for Indian Ocean, 50 for Southern Ocean).

Atlantic Ocean, Pacific Ocean, Indian Ocean have all about 110% of activity (Fig. 21 and 22). The Southern Ocean is the challenge to address with an actual activity of 41% and maybe less (about

30%) if we update the design. Marginal Seas are in good shape with 82%. The Mediterranean Sea is "over sampled" with an activity of 130% and certainly hides a less good implementation of other Marginal Seas.
With regard to the trends, the Pacific Ocean has a slow decrease in activity.
The decrease in the Indian Ocean has been successfully addressed (through the Kaharoa 2016 cruise in particular) and the Atlantic Ocean is increasing its activity.
The Southern Ocean activity has been rather stable around 40%, beyond the seasonal gaps, which decreases the real-time activity by half.

Activity Argo Global	101.28% 1/2017	3753 Target
Activity Argo Global - Atlantic Ocean	110.37% 1/2017	791 Target
Activity Argo Global - Pacific Ocean	112.58% 1/2017	1590 Target
Activity Argo Global - Arctic Ocean	53.9% 1/2017	141 Target
Activity Argo Global - Southern Ocean	41.1% 1/2017	326 Target
Activity Argo Global - Mediterranean Sea	132.14% 1/2017	56 Target
Activity Argo Global - Marginal Seas	82.86% 1/2017	210 Target
Activity Argo Global - Indian Ocean	112.81% 1/2017	695 Target

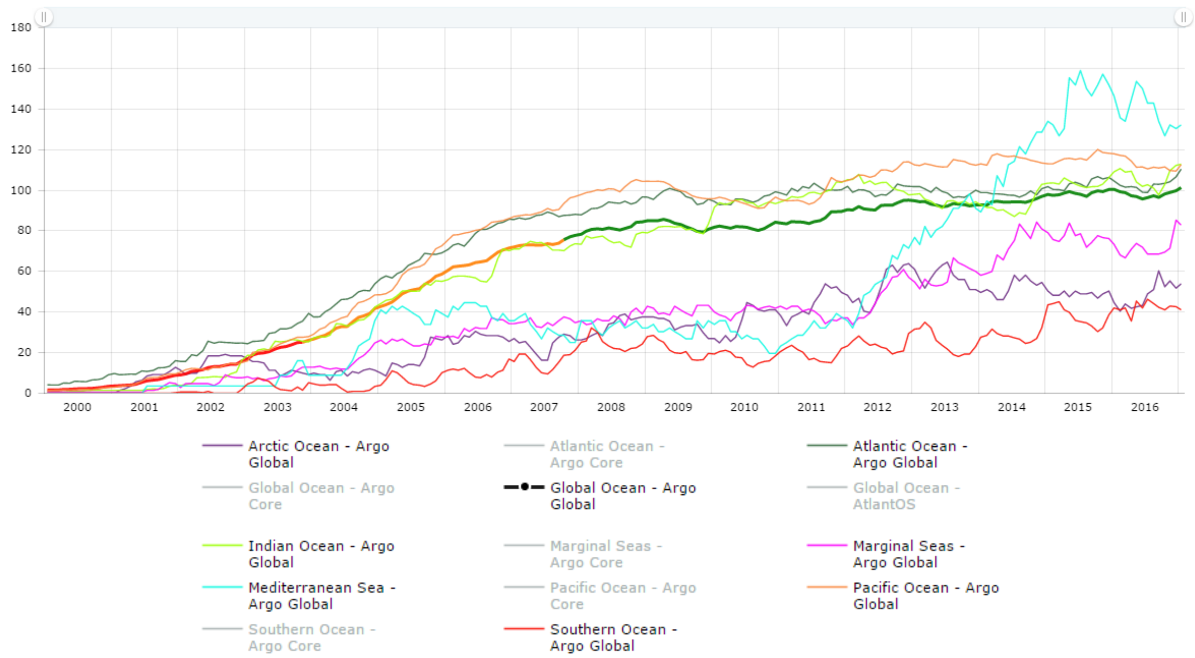


Fig. 21, 22: Activity indicator as of January 2017 and time series.

Coverage

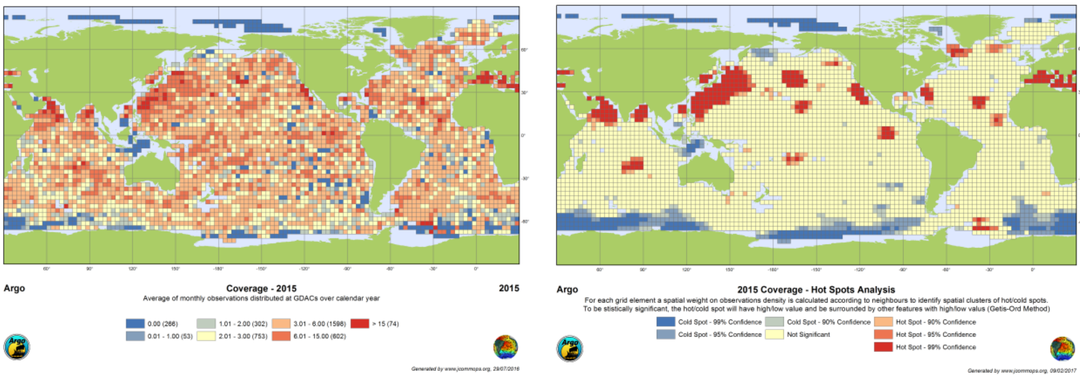


Fig. 23, 24: Argo coverage 2015 and hot spots analysis

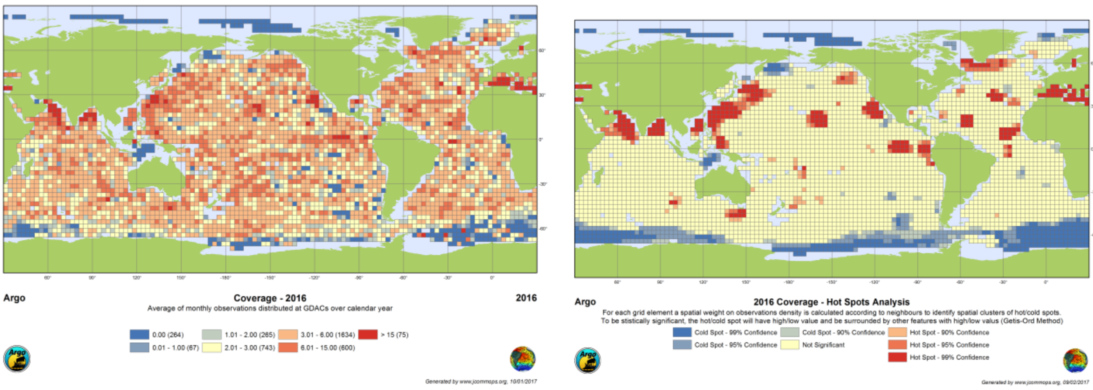


Fig. 25, 26: Argo coverage 2016 and hot spots analysis

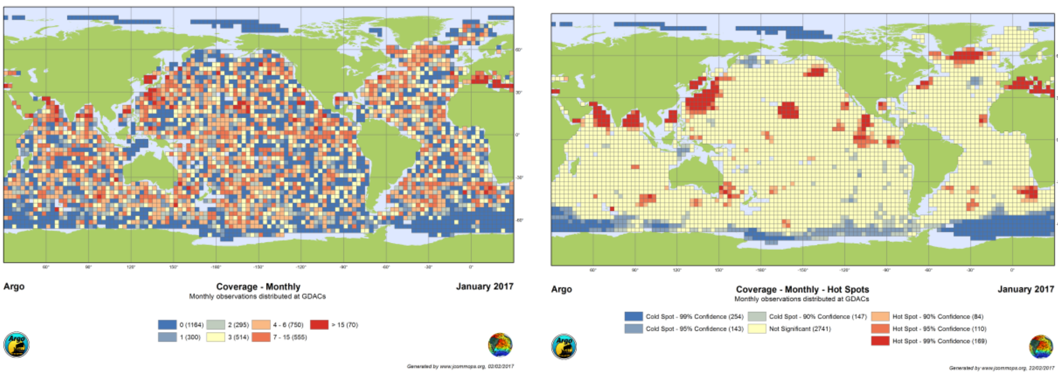


Fig. 27, 28: Argo coverage Jan. 2017, and hot spots analysis

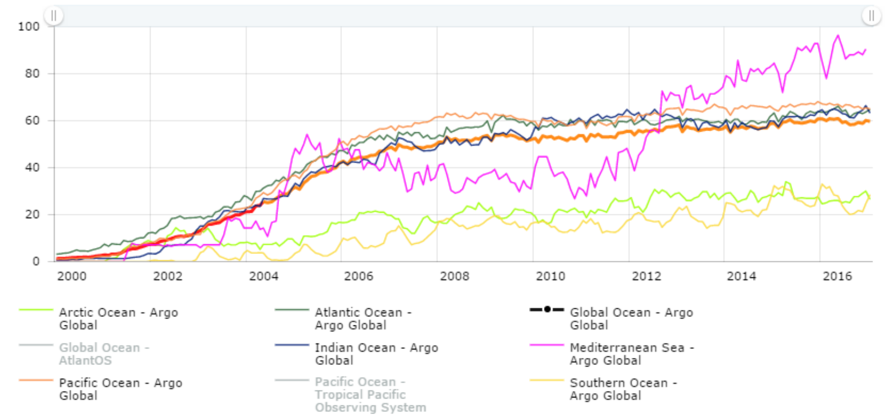
Figures 23-28 show that a number of small gaps in 2015 have not been addressed in 2016 and larger gaps are still the same. The coverage keeps improving lightly for the global array and has certainly reached a plateau where we know that 65% of the array is perfectly sampled (Fig 27-29):

- It is appropriate in the 3 main basins
- Polar extensions are half way vs other basins, and on light decrease since 2015.
- The Pacific Ocean has a slightly better coverage than the others but shows a decrease since 2016.
- Overall coverage in Marginal Seas could be improved and is on clear decrease since 2014.
- The Mediterranean Sea with 89% of coverage seems very well covered, but the target (expected observations/month) may be reviewed and decrease the indicator value.

Coverage (Yearly) Argo Global	66.04% 2016
Coverage (Yearly) Argo Global - Pacific Ocean	73.14% 2016
Coverage (Yearly) Argo Global - Atlantic Ocean	71.05% 2016
Coverage (Yearly) Argo Global - Marginal Seas	48.57% 2016
Coverage (Yearly) Argo Global - Southern Ocean	30.67% 2016
Coverage (Yearly) Argo Global - Mediterranean Sea	89.29% 2016
Coverage (Yearly) Argo Global - Arctic Ocean	28.37% 2016
Coverage (Yearly) Argo Global - Indian Ocean	70.94% 2016

Fig. 29: Yearly coverage indicator values for 2016

Pacific, Atlantic, Indian should appear in green on such KPI chart if we fix the "target" to 70% or less.



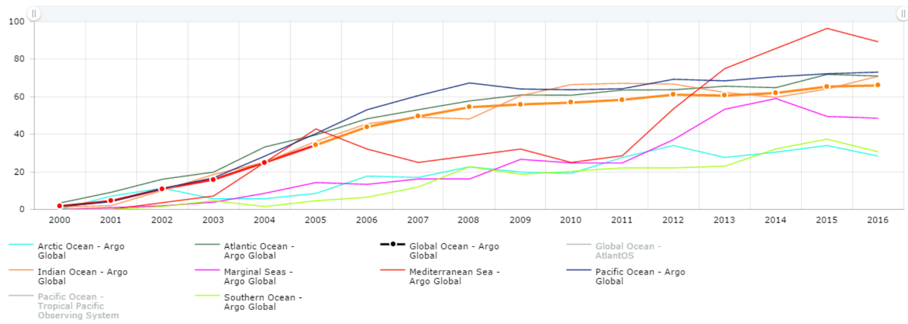


Fig. 30, 31: Monthly coverage, yearly coverage time series

The spatial distribution a seen through the hot spots maps (Fig. 24, 26, 28) shows that we have more oversampling areas than gaps, which is a good news. But the algorithm is not fully adapted to highlight gaps only.
Are those “oversampled” areas due to spatial dispersion caused by oceanic currents or accumulation of deployments in the same place? Deployment hot/cold spots are more or less coverage hot/cold spots (Fig. 30, 31), but area of intense dpeloyemnts does not always coincide with a coiverage hot spot. South East Atlantic and Norwegian basin do not follow this pattern. Labrador/Irminger basins do follow it.

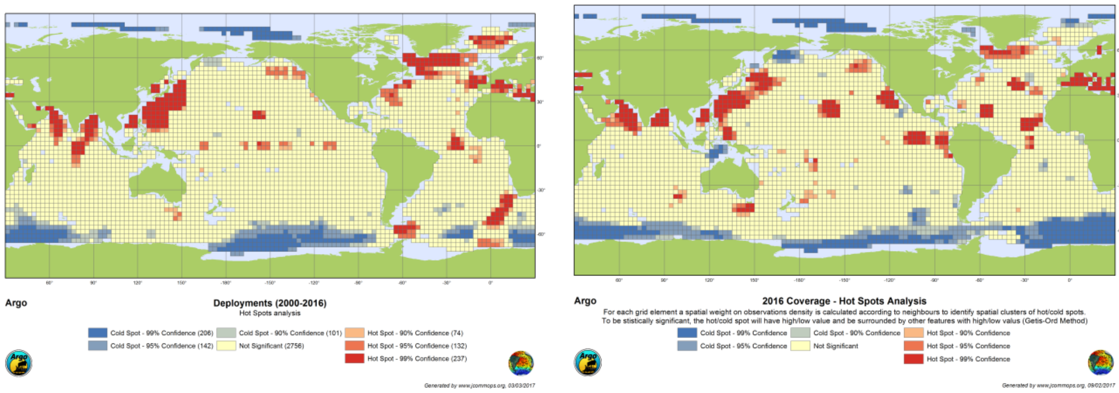


Fig. 32, 33: deployments vs coverage

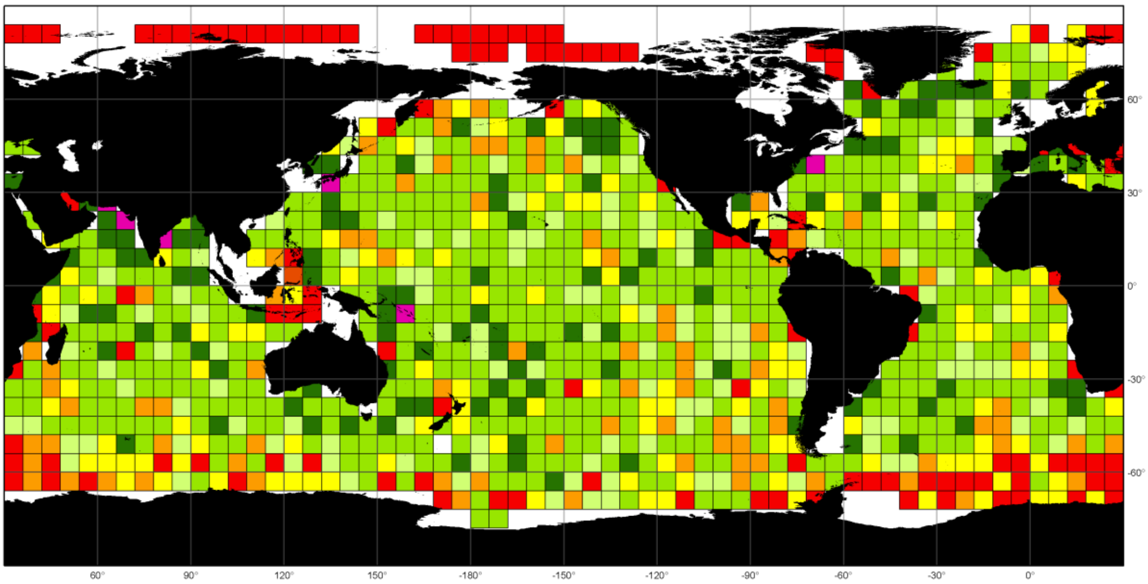
The North Indian Ocean deployments result mainly from extra contribution from China, and US navy. There are no much possibilities for Indian colleagues to be aware of such plans and redirect their deployments elsewhere if there are no advanced notifications and planning.

The North Atlantic deployments are calling for more cooperation between EuroArgo and Canada, and possibly a review of the design with increased target density given the high research interest.

We note finally a few potential accumulation zones, south of Hobart/Tasmania, west of Hawaii, west of Baja California, along the equator in East Pacific due probably to recent important deployments. But maybe some are natural accumulation zones (such as Mindanao). Some other hot spots are known routine deployment opportunities for Sites maintenance (*e.g.* Bermuda, Gulf of Alaska, Hawaii). To be noted the hot spot near Azores rise with a neighboring cold spot.

Argo was declared completed in 2007, and the spatial distribution has been continuously improving since that date. There is a still a margin for improvement in particular for the Southern Ocean.

The density maps may be more appropriate to highlight remaining gaps and provide recommendations for 2017 deployments.
What we can observe as well that there is margin for optimization. If we compare Fig. 35 and 36 (density/age and density/plans), we note thankfully that gaps are decreased, but the number of truly oversampled areas (200-500% density) are doubled after planning (44 to 90), and well/over sampled areas are increased (299 to 351). (See Fig 35, 36 maps legend).
If we don’t weight floats by their probability to survive a year the effect is increased.



Argo **Density - simple** **February 2017**

Profiling floats density, 6° x 6°, normalized on Argo Global design

Ø (118)	25 - 50 % (85)	75 - 100 % (128)	200 - 500 % (122)
0 - 25 % (1)	50 - 75 % (132)	100 - 200 % (448)	> 500 % (6)

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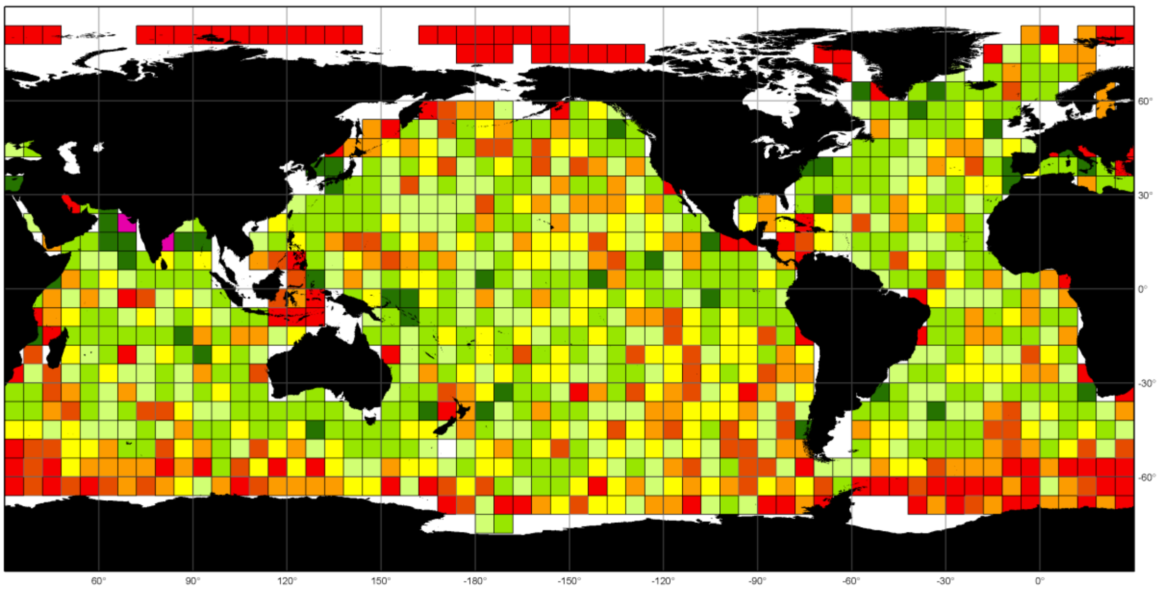

Argo **Density/Age** **February 2017**

Profiling floats density/age, 6° x 6°, noirmalized on Argo Global design.
Floats are weighted by their probability to survive one year.

Ø (119)	25 - 50 % (141)	75 - 100 % (195)	200 - 500 % (44)
0 - 25 % (82)	50 - 75 % (158)	100 - 200 % (299)	> 500 % (2)

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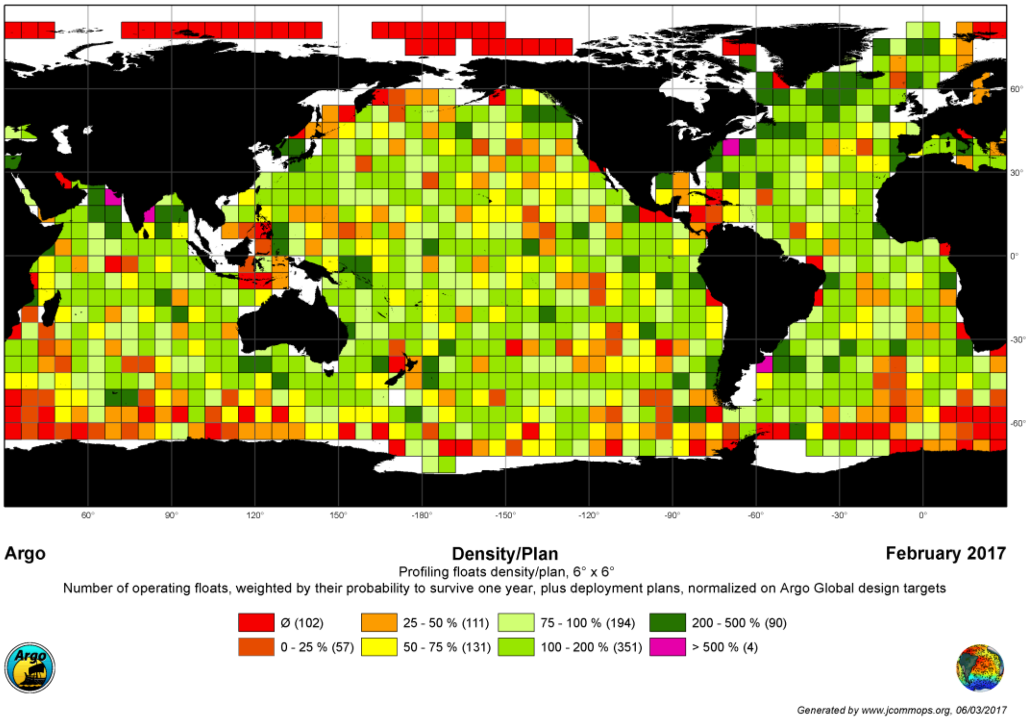


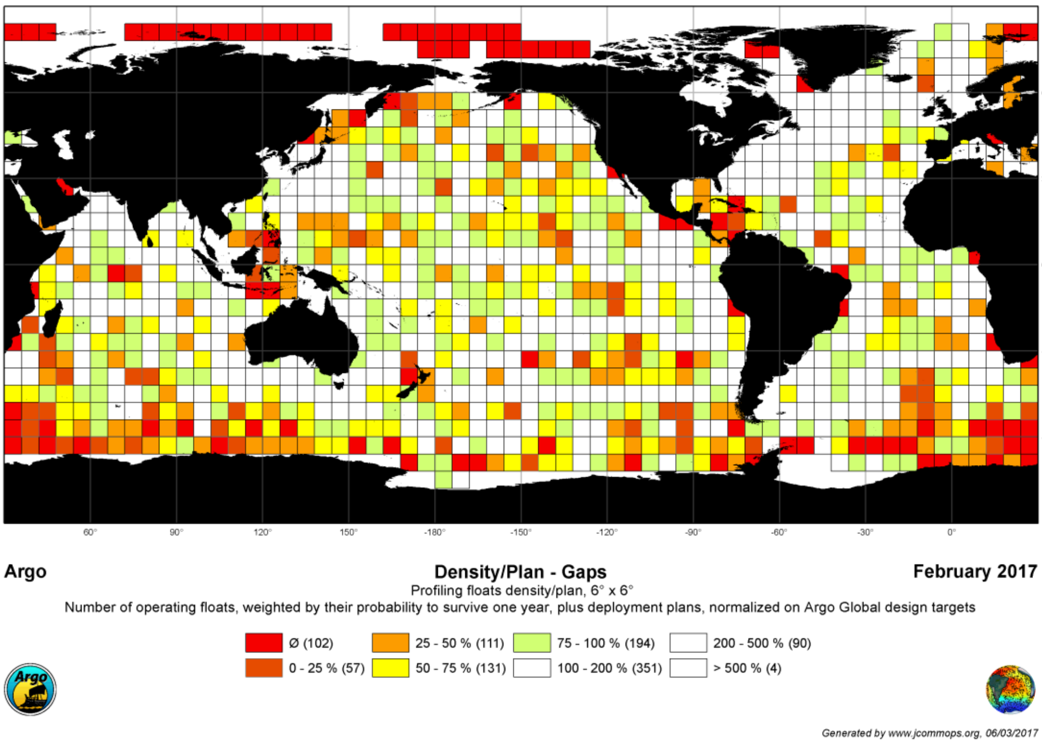


Fig. 34, 37: Latest density of operational platforms; same with floats weighted by their probability to survive one year; same including deployment plans; same with gaps highlighted

⇨ **Recommendation 13:** Use the Fig. 37 (Argo gaps) to plan and optimize next deployments for 2017

Intensity

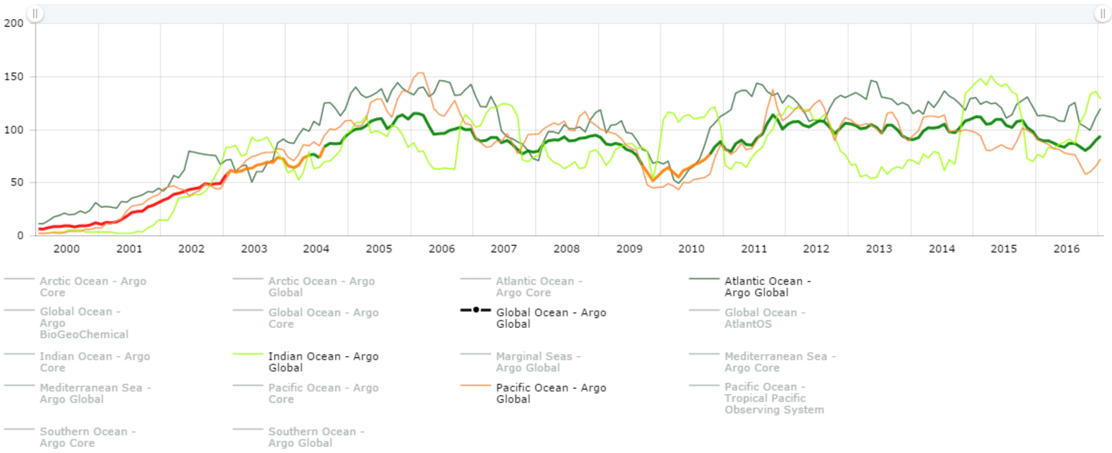
Intensity Argo Global - Arctic Ocean	55.88% 12/2016	34 Target
Intensity Argo Global	94.09% 1/2017	913 Target
Intensity Argo Global - Atlantic Ocean	119.79% 1/2017	192 Target
Intensity Argo Global - Marginal Seas	152.94% 1/2017	51 Target
Intensity Argo Global - Indian Ocean	128.99% 1/2017	169 Target
Intensity Argo Global - Southern Ocean	49.37% 1/2017	79 Target
Intensity Argo Global - Mediterranean Sea	200% 1/2017	14 Target
Intensity Argo Global - Pacific Ocean	72.35% 1/2017	387 Target

Fig 38: Intensity status as of January 2017

After a drop of 25% early 2016, the effort in deployments is now correct for the global array.
It appears too low in Arctic and Southern Oceans and it needs to be doubled to meet the target.
The intensity of deployments in Marginal Seas is rather high and not well distributed (Fig. 38).

The Indian Ocean intensity shows how the Karahoa contribution is critical every 2 or 3 years.

The main warning can be raised for the Pacific Ocean intensity which lacks about 30% of deployments and has been in continuous decrease for last year. Practically the Pacific has potentially accumulated a deficit of about 100 units. This is not visible now in the array activity but will be in next years as part of the array has not been renewed and floats will gradually decay.



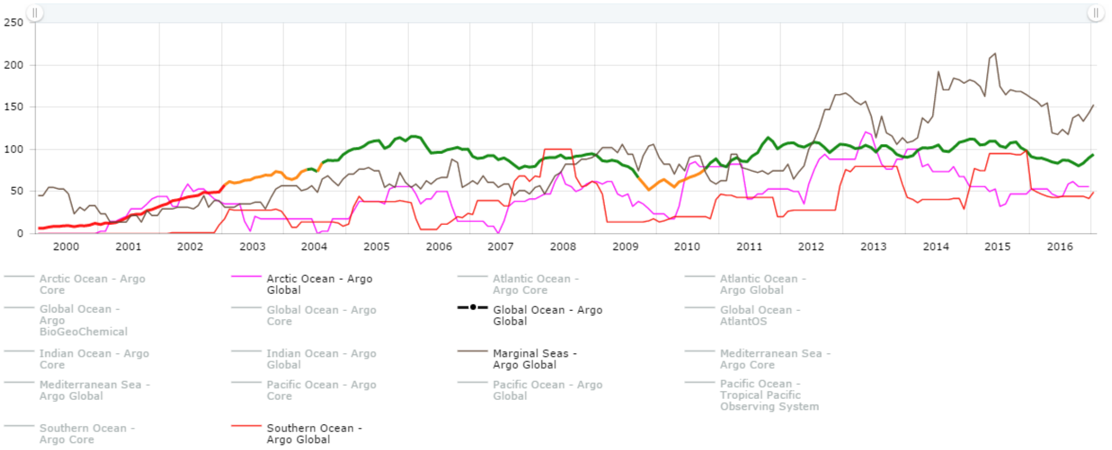


Fig 39, 40: Intensity of deployments for the 3 main basins, and for Polar/Marginal Seas expansions areas.

- ⇨ **Recommendation 14:** Increase the deployments in the Pacific Ocean in 2017 (order of 100 extra units, for a total of 487 floats).
- ⇨ **Recommendation 15:** Double the number of deployments in Southern Ocean
- ⇨ **Recommendation 16:** Review the potential partners for each Marginal Sea, as some doesn't seem to have regular and "core Argo" implementers.

If we consider the high mortality rate in the Mediterranean Sea, a current intensity of 200% seems just adequate.

It would be interesting to look at intensity values on smaller basins but there are no performance indicator yet developed.

Regional perspectives

Sub-basins

The following table provides additional indicators (not yet available on the website) for sub basins and main marginal seas.
The intensity value is based on 2012-2016 average deployments.

	Activity target	Activity status	Intensity target	Intensity status *	2016 Coverage	> 5 years
North Atlantic	341	**120%**	83	**147%**	**80%**	11%
South Atlantic	450	**98%**	109	**104%**	**64%**	11%
North Indian	88	**184%**	21	**233 %**	**91%**	12%
South Indian	607	**101%**	148	**82%**	**68%**	24%
North West Pacific:	465	**109%**	113	**140%**	**78%**	26%
North East Pacific:	254	**124%**	62	**91%**	**72%**	30%
South West Pacific:	366	**129%**	89	**90%**	**82%**	33%
South East Pacific:	505	**95%**	123	**55%**	**63%**	30%

Table 4: Activity, Intensity, Coverage, old floats proportion for sub-basins.

There is an excess of active floats and deployments in North Atlantic. It is rather difficult at that time to identify which proportion of these floats are extras (eq. or BGC) contributions, as they are linked to regular programmes but a 50/50 could be a good approximation. However this excess contributes to the improvement of the coverage of the area.
The South Atlantic has an appropriate activity, and intensity of deployments. Its coverage could be however improved and a few gaps remain. Proportion of old floats is not problematic at all.

- ⇨ **Recommendation 17:** Slowing down the rhythm of deployments in North Atlantic would not hurt.

The North Indian Ocean meets the requirements of marginal seas, with an activity of 184%, and intensity of 233% and an excellent coverage of 91%. The intensity is however appropriate without equivalent or BGC contributions. Age distribution is not problematic, and this basin will be in good shape for next years.
The South Indian Ocean shows some good statistics, however deployments intensity should be slightly increased (+25 per year) to improve and sustain the coverage, as a quarter of the sub basin floats has reached 5 years.

- ⇨ **Recommendation 18:** A pause in deployments in North Indian Ocean would not hurt and priority should be given to the south region for 2017.

The North West Pacific shows good statistics and shows an excess of floats (45 per year) which is not fully contributing the WBC expansion for Kuroshio observations (see section on WBC), but improving the coverage anyway. This excess is due to extras contributions. A quarter of the floats have reached 5 years.
North East Pacific shows very good statistics but a third of floats is older than 5 years old. Intensity is low by 10%.

The South Pacific Ocean has a very good coverage with just the adequate number of floats, in particular in the south west region. It has certainly the best ratio intensity/coverage. Implementation plans is more optimized than in other areas. So we take note here again of the Kaharoa contribution, revealed critical in the South Pacific Ocean.
With less floats and appropriate ship time to launch them where needed in priority for the global perspective, we improve the overall coverage. (90 % intensity for 82% coverage vs 147% intensity for 80% coverage in North Atlantic ocean).
The South East Pacific has an appropriate activity but a problem of rhythm of deployments with a too low intensity (55%). A deficit has certainly been accumulated, hidden by the very good performance of floats, as a third of the array is above 5 years old.

- ⇨ **Recommendation 19:** Double the intensity of deployments in South East Pacific (up to 125 in 2017)

107 floats are planned to be deployed via the Kaharoa in 2017 so this recommendation is not necessary,and just confirms the implementation plan set up.

Marginal Seas

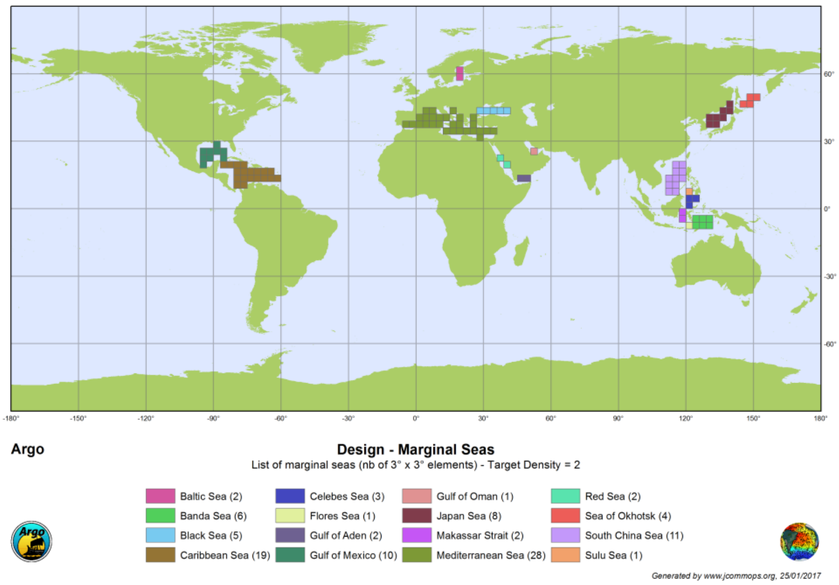


Fig. 41 Argo Design for Marginal Seas for a total of (105 x 2) floats

	Activity target	Activity status	Intensity target	Intensity status *	2016 Coverage	> 5 years
Japan Sea	16	**206%**	4	**170%**	**13%**	12%
South China Sea	22	**73%**	5	**188%**	**82%**	0%
Med. Sea	56	**128%**	14	**241%**	**89%**	0%
Black Sea	10	**80%**	2	**200%**	**80%**	0%
Caribbean Sea	38	**45%**	9	**60%**	**21%**	6%
Gulf Of Mexico	20	**65%**	5	**120%**	**40%**	8%

Table 5: Activity, Intensity, Coverage, old floats proportion for main Marginal Seas

Implementation for Caribbean Sea and Gulf of Mexico shows progress. All other main marginal seas have a 200% intensity which confirms, by the practice, the proposed double intensity targets (Table 5). There is potentially an issue of data distribution or implementation plan, with the Japan Sea as we have a lot of active floats, deployments, but a very poor coverage.

⇨ **Action 3:** (JCOMMOPS) Develop indicators for sub-basins

TPOS

TPOS region covering the Pacific Ocean zone from 30°N to 30°S, shows good performance indicators. The activity is over 100% but the array has lost 25% floats last year. TPOS has one of the best coverage indicators (76%), but the intensity of deployment is too low and will result in a decline of the array. Amongst the 100 extra units required for the Pacific Ocean, half of them should target TPOS region.
Finally we can note that many TPOS floats are getting old, actually very old. More than hundred floats are over ten years old (Fig. 43, 44). These floats are APEX deployed mainly by “Argo PMEL” and “Argo UW” through Kaharoa and Kaimimoana.
The lead float is UW #5900426 (455 profiles, well to 1000 dbar only).
But half of these floats were actually profiling to 2000 dbar (*e.g.* UW #5900947).
That said, at any time TPOS can lose 100 units.

Float sample size	106
% Operational Floats	100
Oldest Platform (Days)	4787
Average Age (Days)	3857
Median Age (Days)	3894
Average Dist. Per Float (Km)	560
Average Cycles Per Float (Km)	385
% Failed Deployments	0
% Blacklisted	2.83
Total observations	38527
DM observations	23365

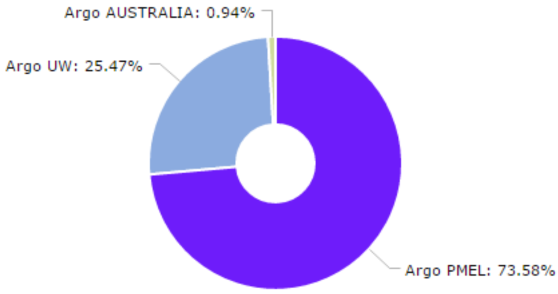
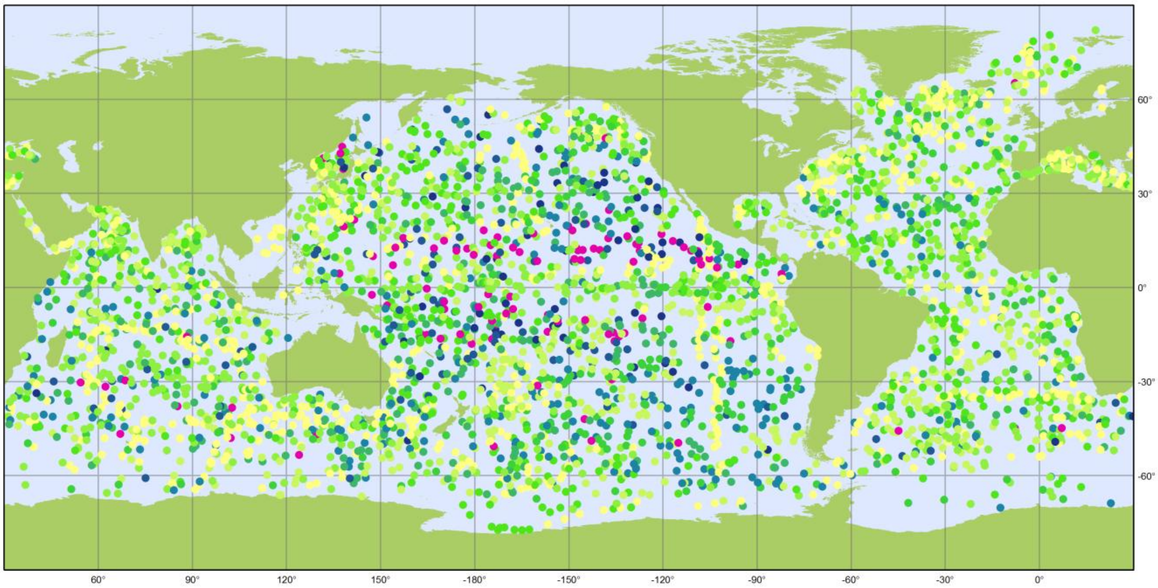


Fig. 42 TPOS floats > 10 years



Argo **Age** **January 2017**

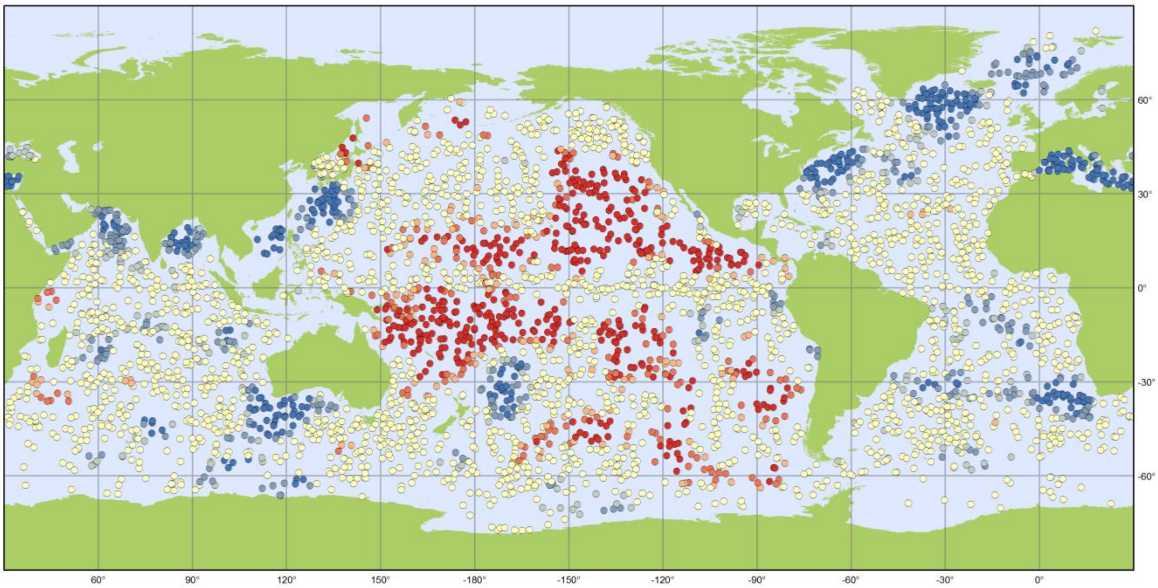
Profiling floats age distribution (in years)

<1 year (792) 2-3 (761) 4-5 (347) 6-7 (0) 8-9 (101) >10 years (106)

1-2 (686) 3-4 (514) 5-6 (324) 7-8 (276) 9-10 (65)

Mean = 3.23 Median = 2.61

Generated by www.jcommops.org, 02/02/2017



Argo **Age - Hot Spot Analysis** **January 2017**

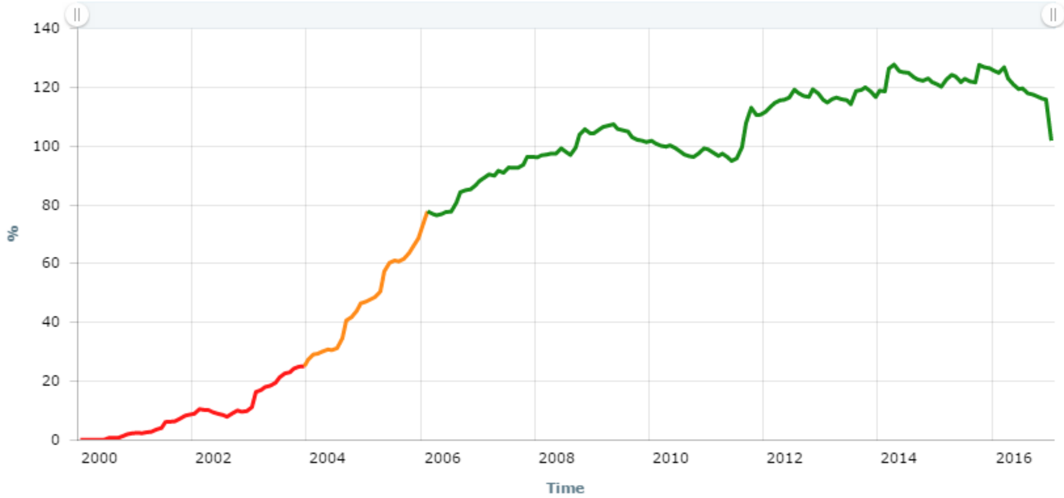
For each float a spatial weight on age is calculated according to neighbours to identify spatial clusters of hot/cold spots.
To be statistically significant, the hot/cold spot will have a high/low value and be surrounded by other features with high/low values. (Getis-Ord Method)

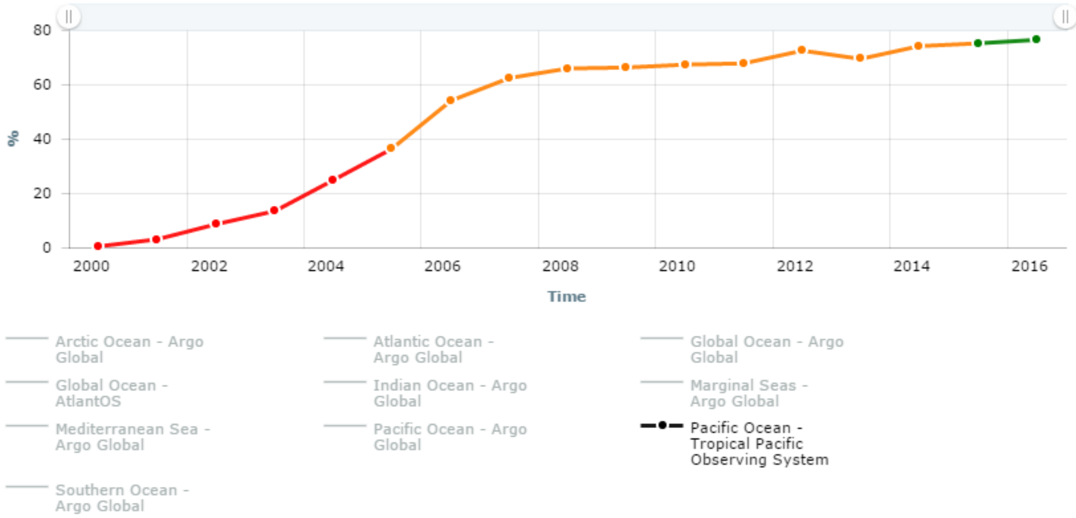
Cold Spot - 99% Confidence Cold Spot - 90% Confidence Hot Spot - 90% Confidence Hot Spot - 99% Confidence

Cold Spot - 95% Confidence Not Significant Hot Spot - 95% Confidence

Generated by www.jcommops.org, 02/02/2017

Fig. 43, 44: Analysis of young/old float; spatial clusters





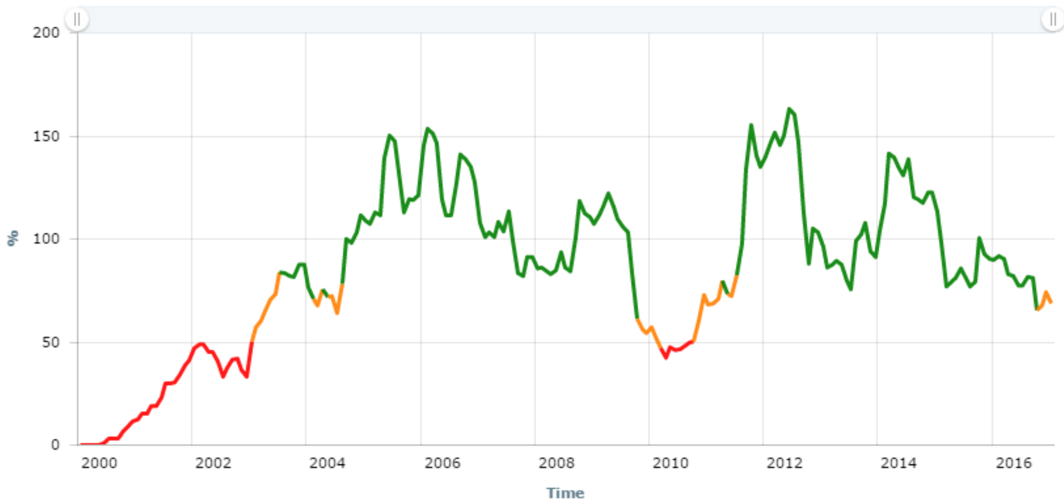


Fig. 45, 46, 47: TPOS floats activity, coverage and intensity time series

Implementation		
Activity Tropical Pacific Observing System - Pacific Ocean	101.85% 1/2017	892 Target
Coverage (Monthly) Tropical Pacific Observing System - Pacific Ocean	59.37% 1/2017	75% Target
Coverage (Monthly, sum) Tropical Pacific Observing System - Pacific Ocean	66.67% 1/2017	75% Target
Coverage (Yearly) Tropical Pacific Observing System - Pacific Ocean	76.58% 2016	75% Target
Intensity Tropical Pacific Observing System - Pacific Ocean	68.78% 1/2017	217 Target

Fig. 48, TPOS KPIs January Status

⇨ **Recommendation 20:** Deploy at least about 250 units in the TPOS region to maintain the array and anticipate a 10% decrease in activity soon.

At the time of writing this report 129 floats are going to be deployed in TPOS region.

Extensions

Targets

Target and status of expansions areas are provided for information (Table 6). No particular recommendation is provided considering that these extensions are not yet endorsed by the AST or are just in a pilot phase.
The intensity target calculation may not be appropriate as floats will likely drift rather fast from the area considered. A map of residence time might help to finalize the target values.

	Targets Argo		**Targets Argo 2020**		**Extra cost/year**
	Activity	Intensity	Activity	Intensity	
Equatorial	**168**	**41**	**252**	**61**	**20**
Eq. Atlantic Ocean	35	8	52.5	13	5
Eq. Indian Ocean	36	9	54	13	4
Eq. Pacific Ocean	97	24	145.5	35	11
WBC	**459**	**112**	**1033**	**251**	**139**
WBC - Agulhas	113	27	254	61	34
WBC - East Australian	59	14	133	32	18
WBC - Gulf Stream	49	12	110	26	15
WBC - Kuroshio	51	12	115	28	16
WBC - Malvinas/Falklands	93	23	209	50	28
WBC - Mindanao	56	14	126	30	17
WBC - Solomon Sea	38	9	85	20	11

Table 6: Targets for extension areas

Equatorial

Activity of Equatorial zones is appropriate overall except in Atlantic Ocean where this proposed extension doesn't seem to be implemented yet.
The coverage is very good in the Pacific Ocean, good in Indian Ocean, but not appropriate in Atlantic Ocean.
However, the intensity of deployments needs to be doubled overall in every basin to meet the targets and avoid a decrease of the equatorial zones activity and coverage.

%	Activity	Coverage	Intensity
Eq. Pacific	119	77	55
Eq. Indian	85	56	61
Eq. Atlantic	58	23	67
Eq. Total	98	61	57

Table 7: KPIs for equatorial band.

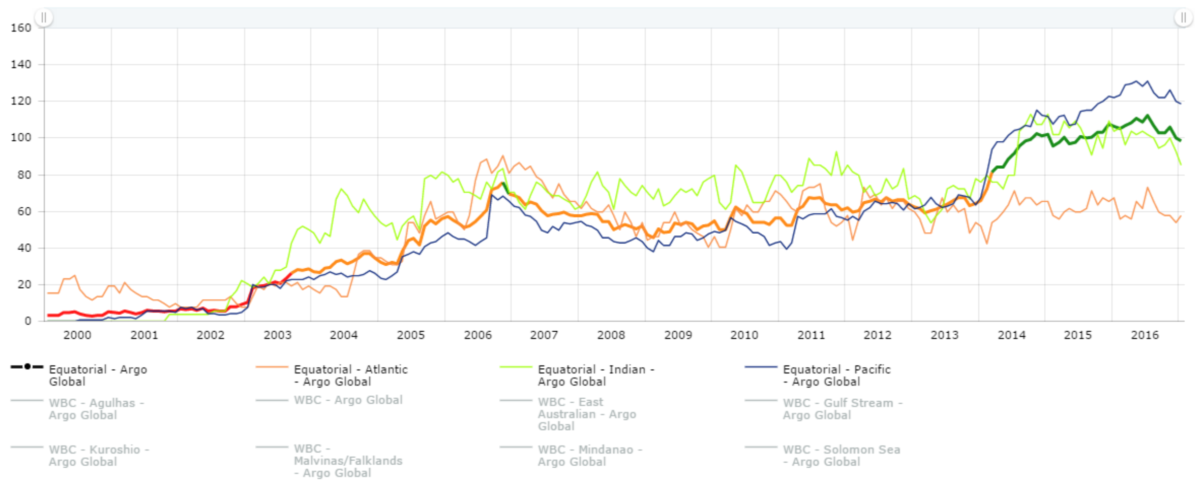


Fig 49: Activity in the 3 Equatorial Basins

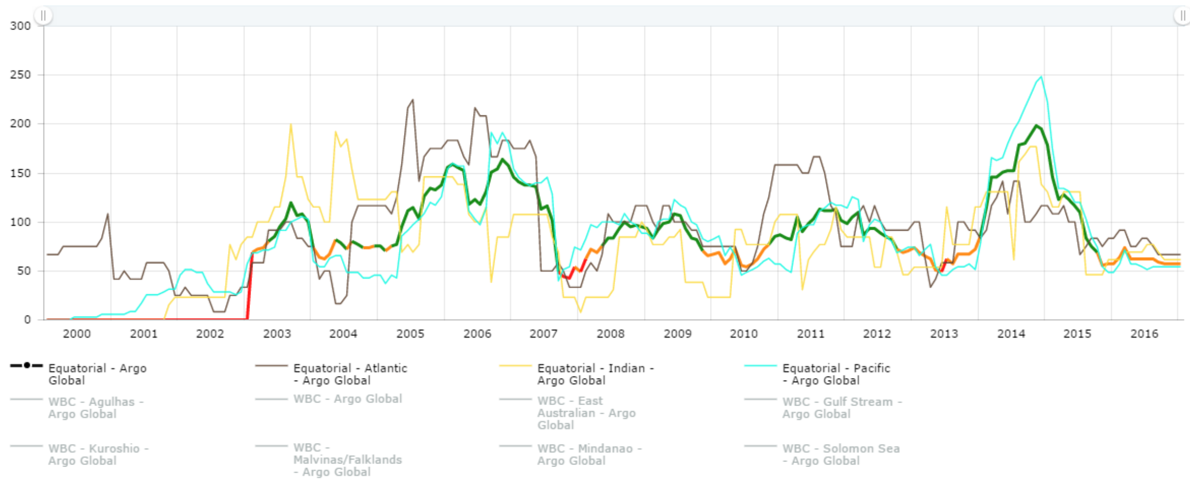


Fig. 50: Intensity in the 3 Equatorial Basins

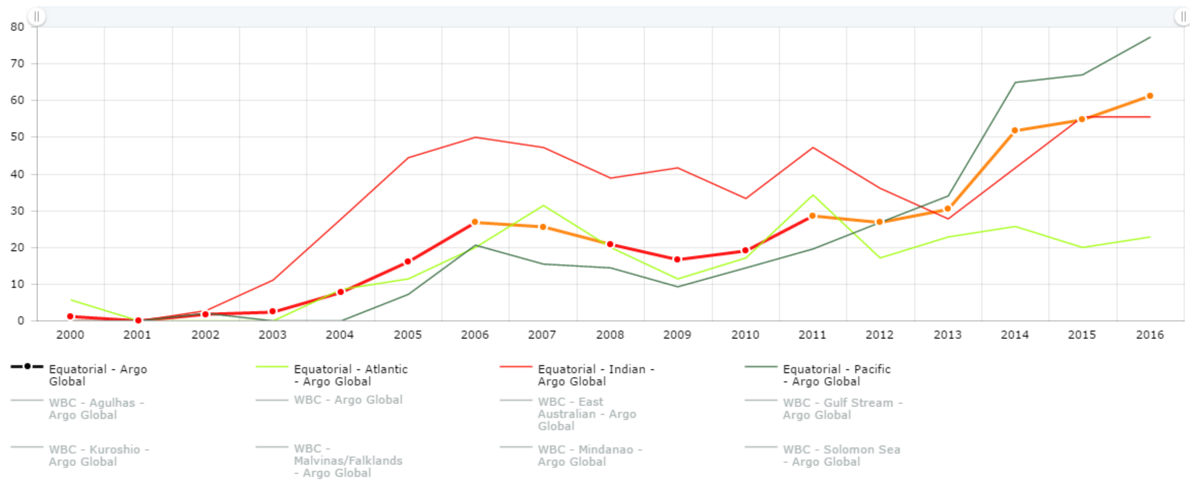


Fig. 51: Coverage in the 3 Equatorial Basins

WBC

%	Activity	Coverage	Intensity
WBC	58	15	45
WBC - Agulhas	51	1.8	52
WBC - East Australian	58	19	47
WBC - Gulf Stream	70	20	115
WBC - Kuroshio	66	33	22
WBC - Malvinas/Falklands	61	12	40
WBC - Mindanao	41	18	37
WBC - Solomon Sea	78	24	0

Table 8: Status for WBC areas vs Argo 2020 design

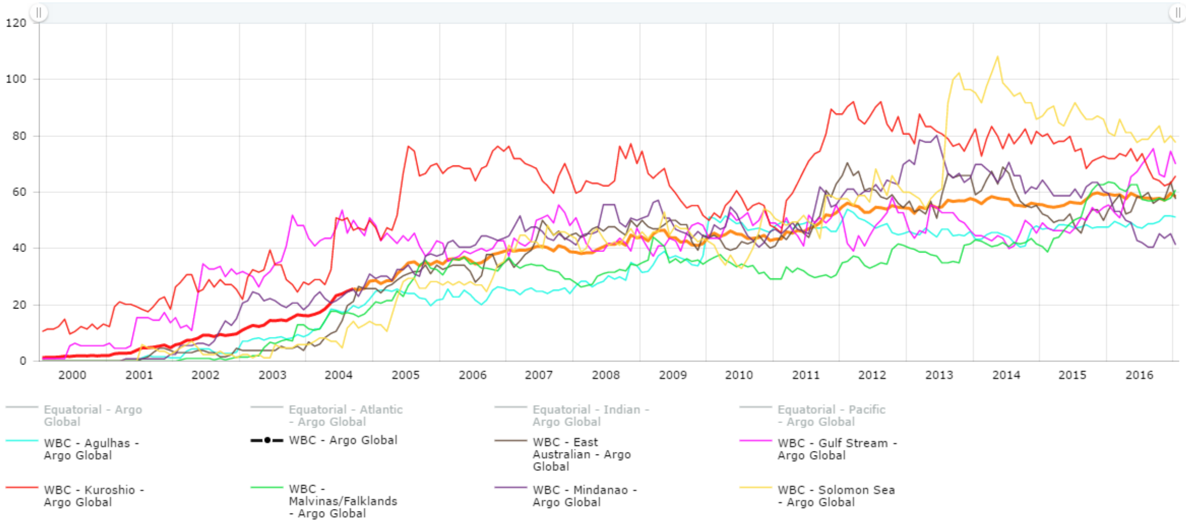


Fig. 52: WBC Activity

The activity of the WBC areas has slowly progressed to reach a plateau around 55% for the last couple of years.

Agulhas WBC activity is stable, and the deployment hot spot in the south east Atlantic doesn't seem to contribute to the WBC; floats are not drifting north enough when they enter the Indian Ocean.

Malvinas/Falklands WBC is progressing, and Gulf Stream is progressing rapidly thanks to high deployment intensity.

Mindanao is dropping, East Australian slowly progressing. Solomon Sea was at 100% in 2014 but is decreasing continuously since then, and Kuroshio was close to 100% in 2012 and is continuously decreasing as well.

The WBC coverage is decreasing since 2013. All areas are on decrease except the Gulf Stream and East Australian current.

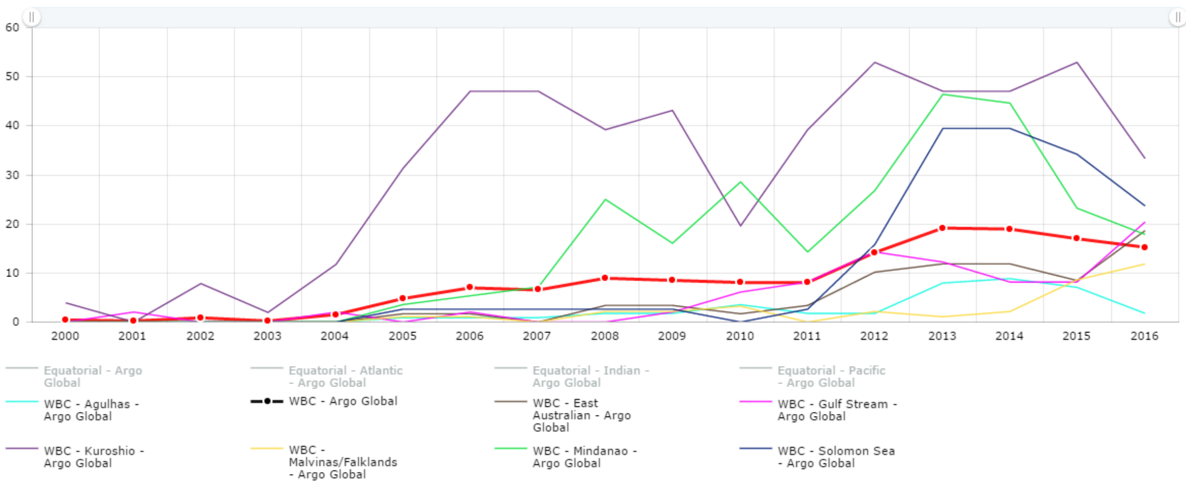


Fig. 53: WBC Yearly Coverage

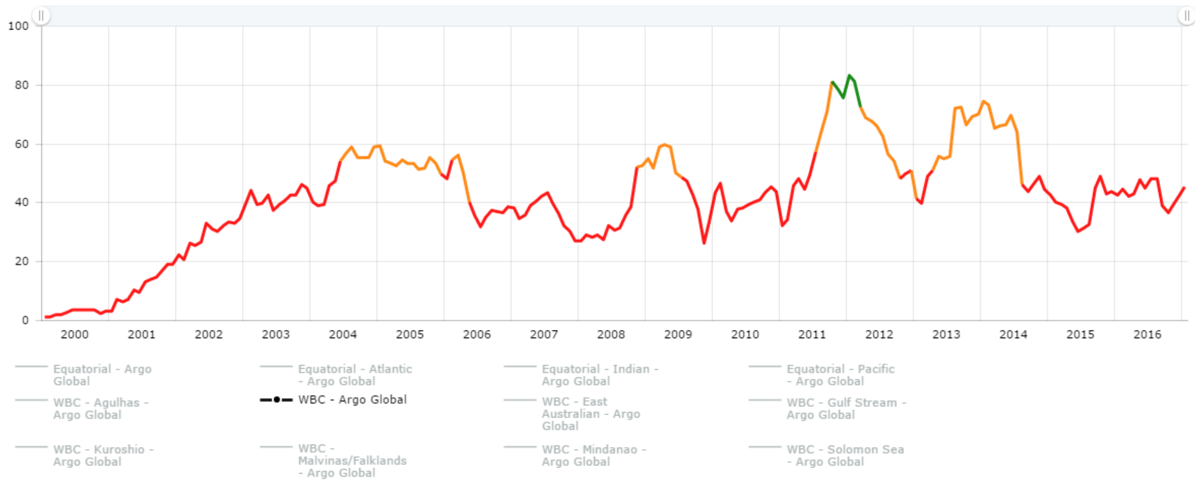


Fig. 54: WBC Intensity

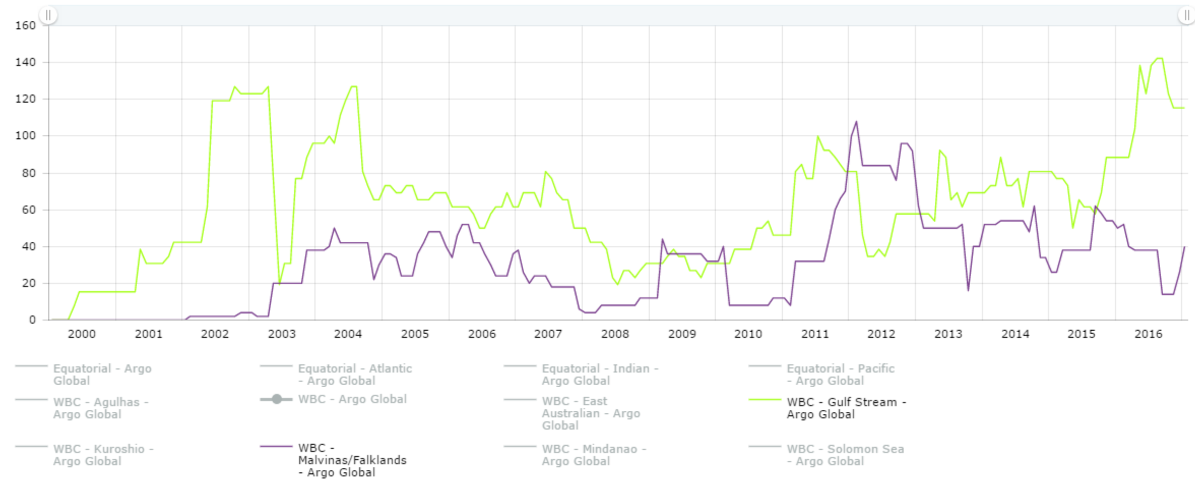


Fig. 55: WBC Intensity (Atlantic)

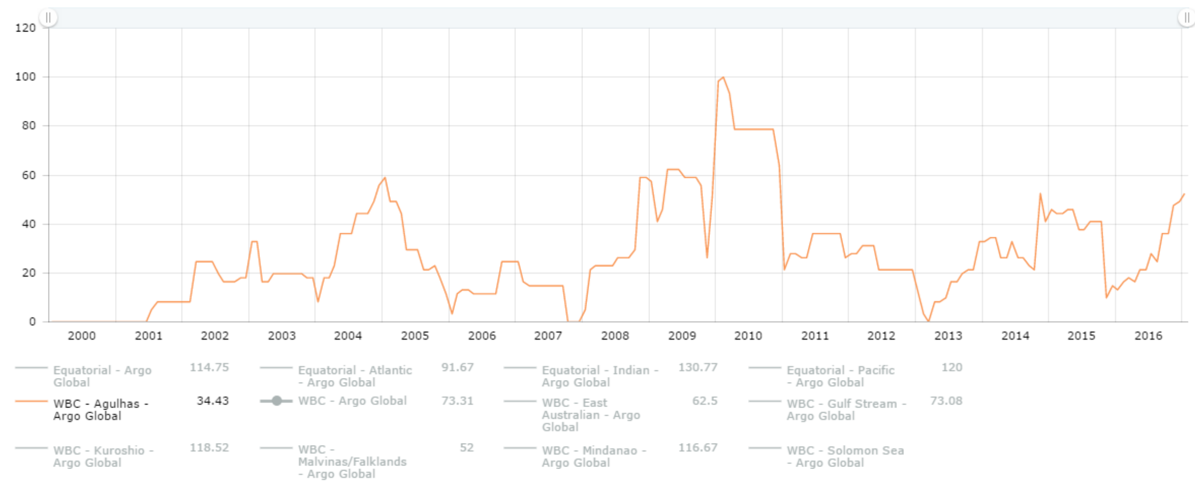


Fig. 56: WBC Intensity (Indian)

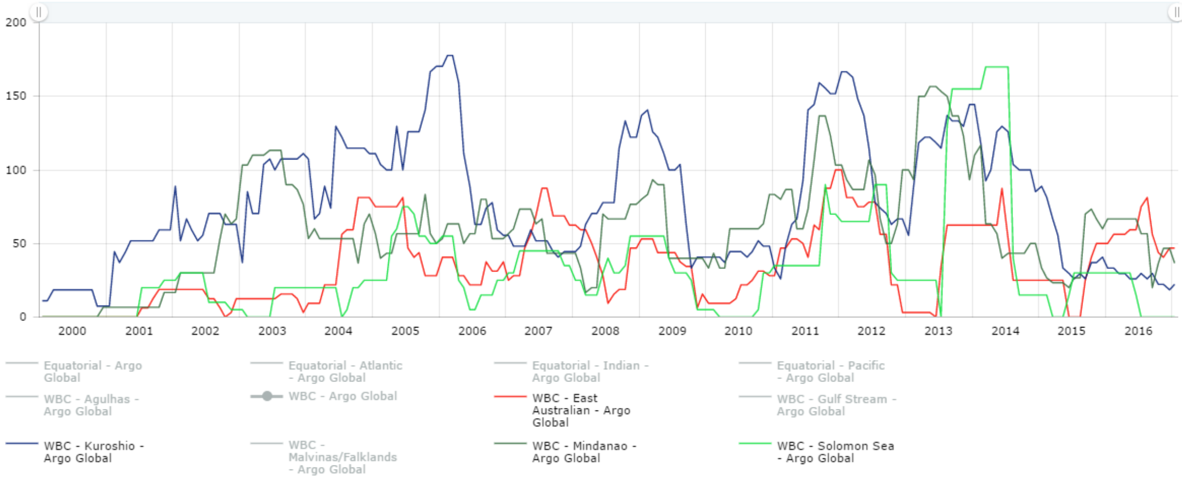


Fig. 57: WBC Intensity (Pacific)

The intensity indicator confirms or explains these trends. For the last 5 years, we divided per two the number of floats deployed in WBC:

- Gulf Stream is boosted by a high intensity so we should see some progress on the coverage in a near future.
- Malvinas/Falklands WBC is on decrease.
- Agulhas and East Australian currents are progressing modestly.
- Solomon Sea has dropped to 0% since July 2016.
- Mindanao is also decreasing.
- Kuroshio has still the best coverage of all WBC regions but a too low intensity will decrease the quality of this area.

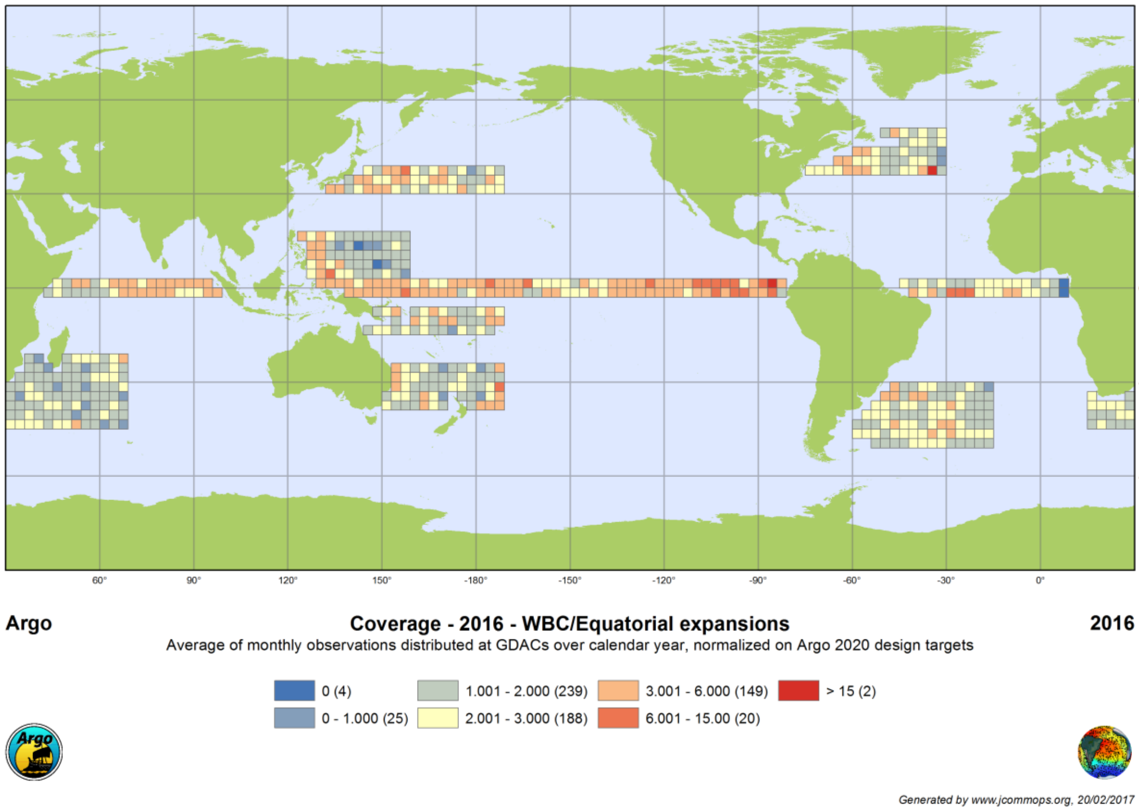
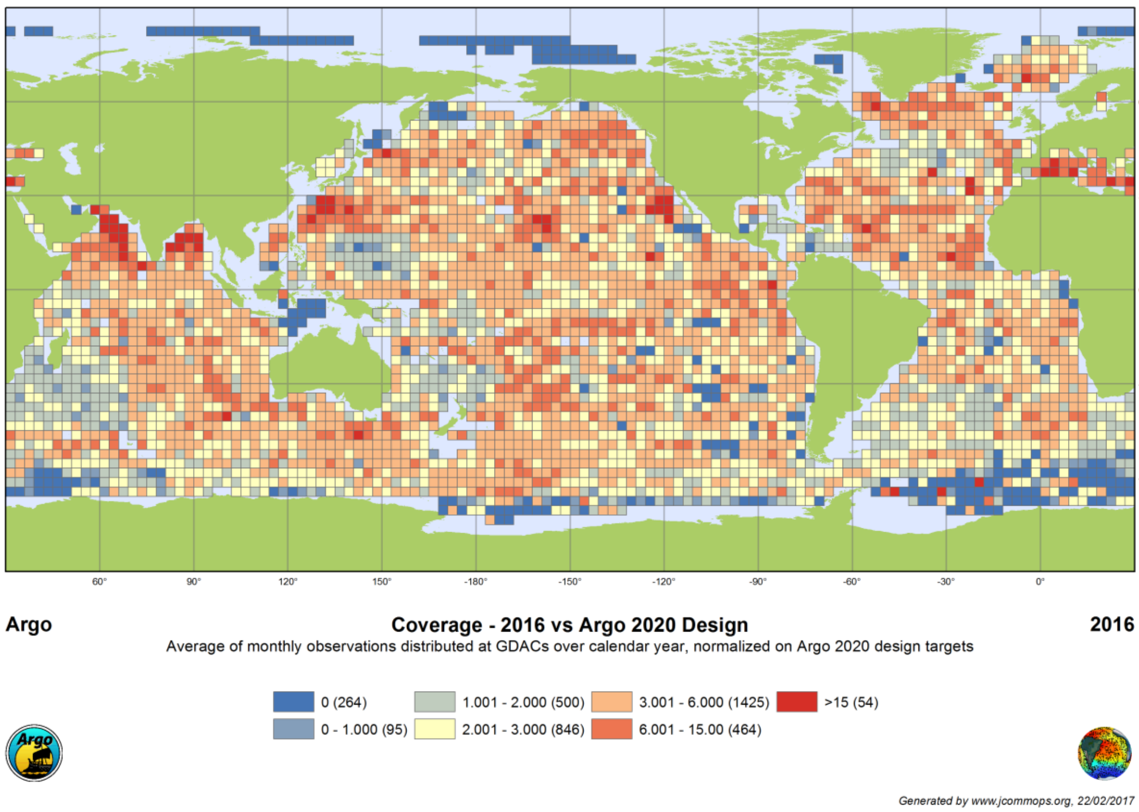


Fig. 58: Coverage in Argo 2020 extensions



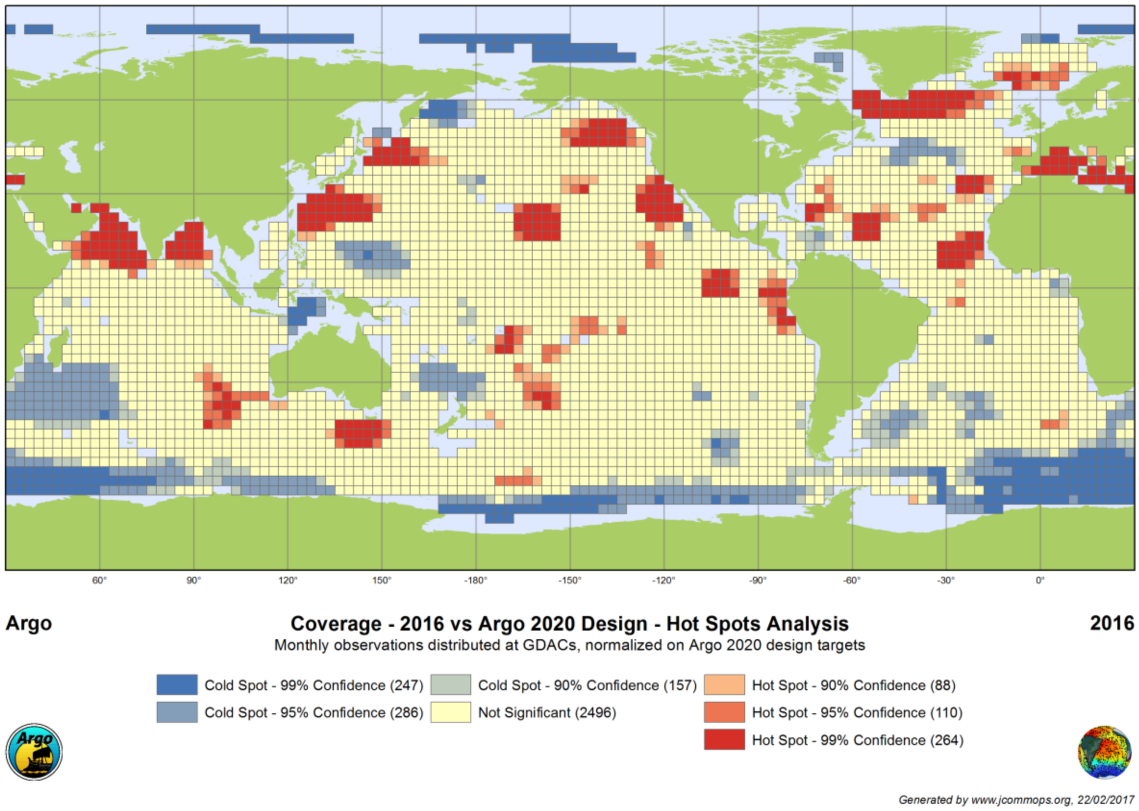


Fig. 59, 60: Argo coverage vs 2020 Design and hit spots analysis

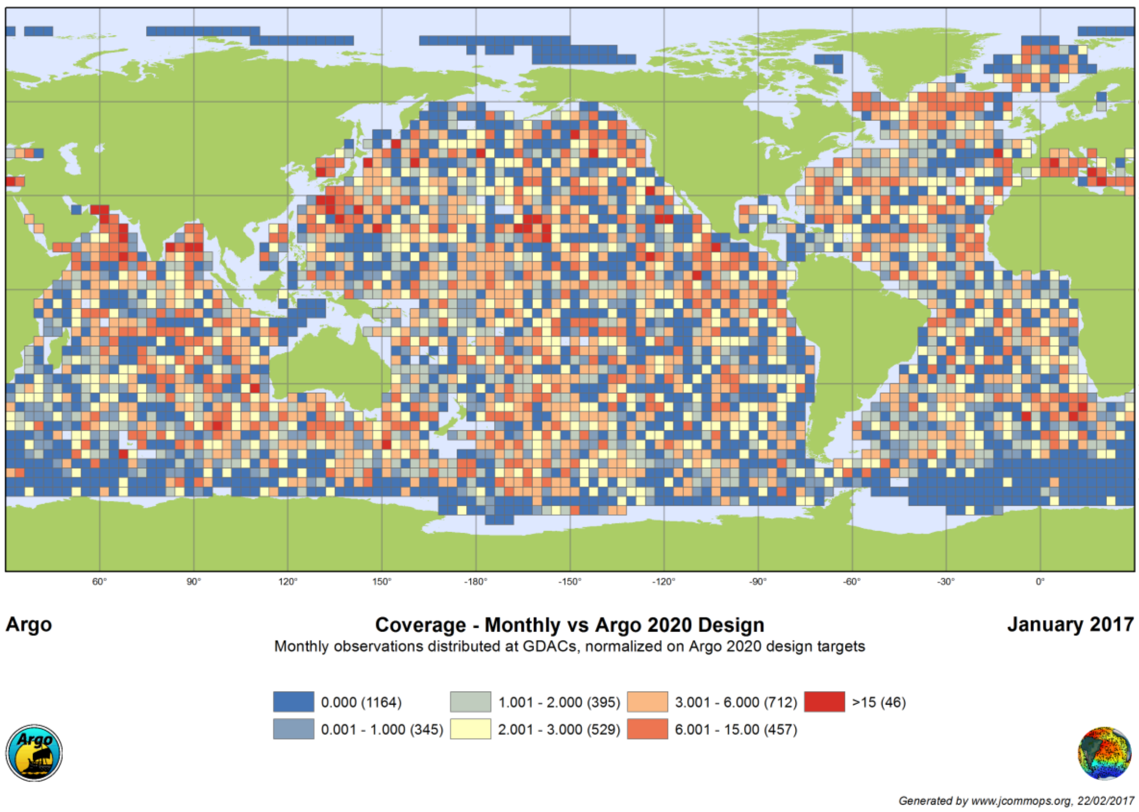


Fig. 61: Latest monthly coverage for Argo 2020 design

Planning

At the time of finishing this report the planning for the year counts 628 units, including the ones already deployed early 2017. 2/3rd of the work is done, most of partners have provided their plans but some still need to do it.
Hence we have no much information on planning for Indian Ocean and North West Pacific Ocean.

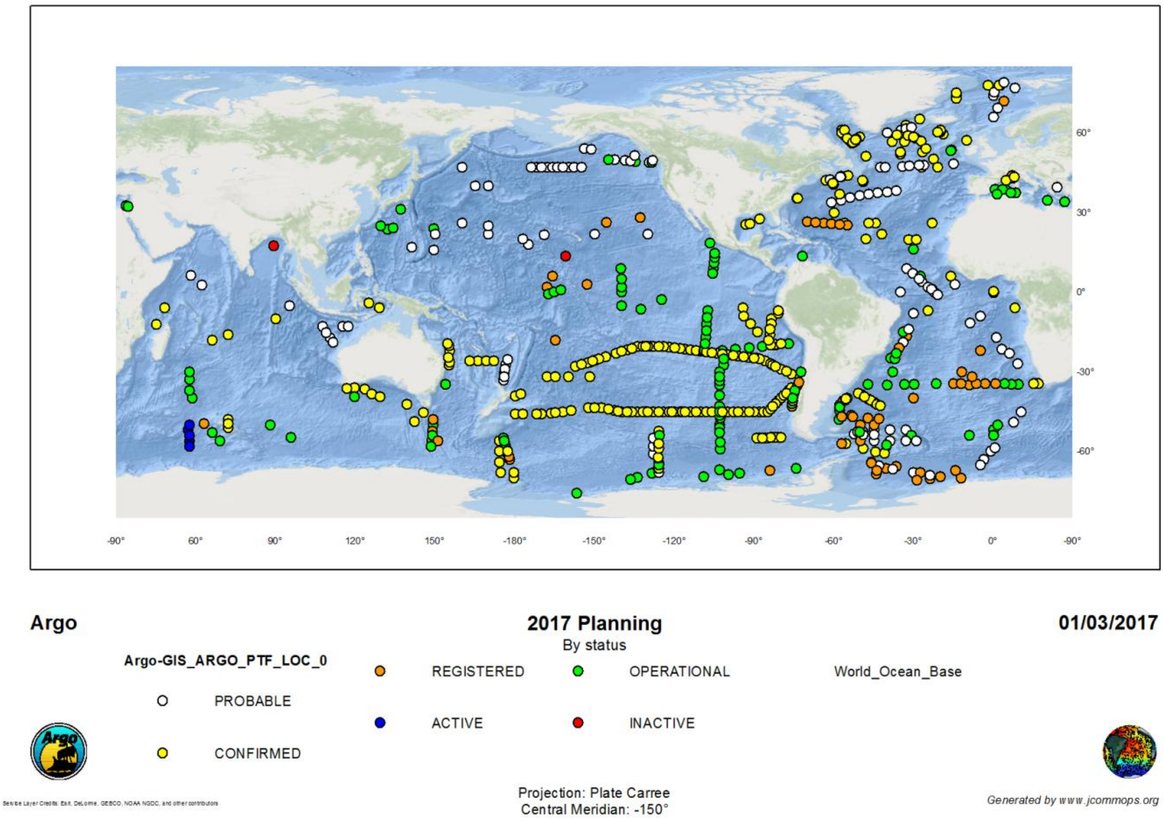
It is critical to share this information ahead of the yearly meeting. We have seen earlier in this report that core Argo was under funded, so we need to take the best of the existing resources.

The new commitments table on argo.jcommops.org could be used during the meeting to review national commitments and their distribution across basins. (See website section Metrics/Commitments)
If at beginning of the year we can agree on the volume of floats deployed in each basin, we can avoid misbalances and progress toward the sustainability of the array.
The on-line tool allows also for projection a year ahead, taking into account the float mortality rate and commitments.

- ⇨ **Recommendation 21:** AST Members to provide yearly commitments i) by network (core, equivalent, BGC, deep) and ii) to distribute these commitments by basin.

Once this is done, each individual program can gradually register plans on the website (through different formats) with the active help of the Technical Coordinator.

- ⇨ **Recommendation 22:** (routine) AST Members to regularly check the AIC/JCOMMOPS website and work with the TC to ensure the planning information is correct and up to date.



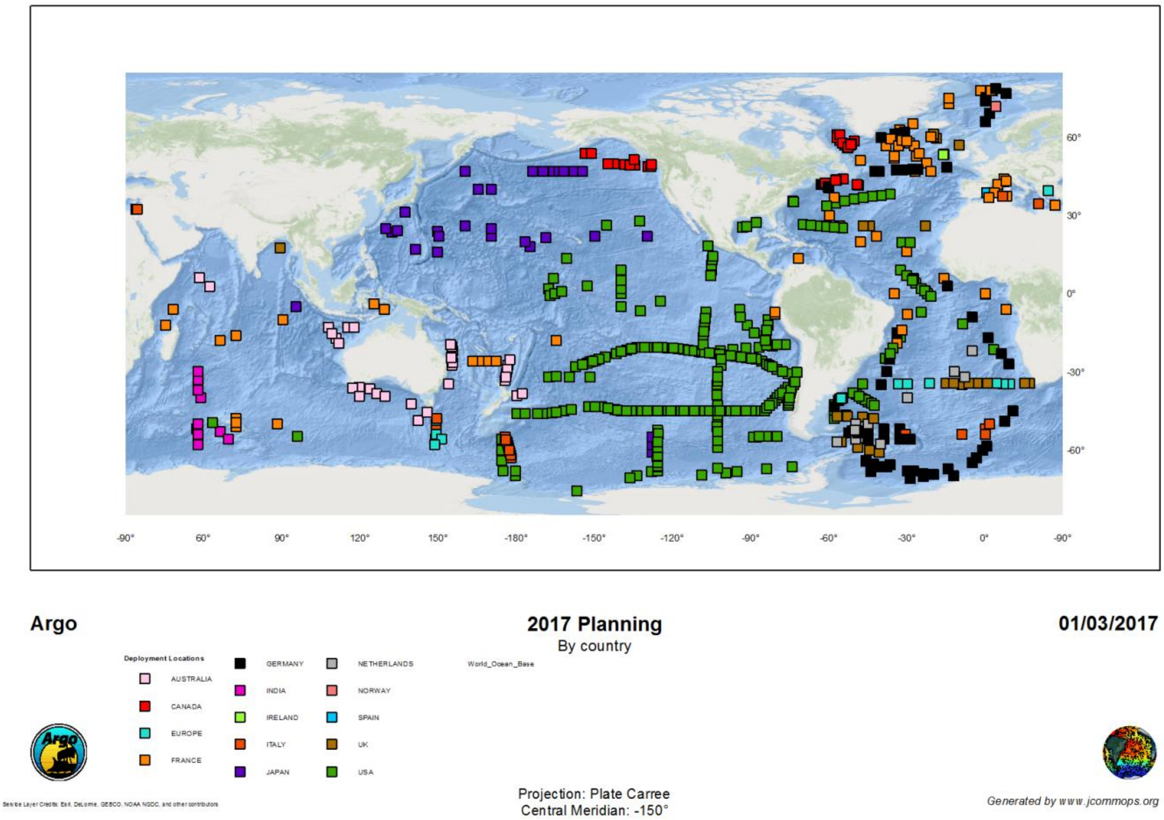


Fig. 62, 63: 2017 deployments by status, and by country

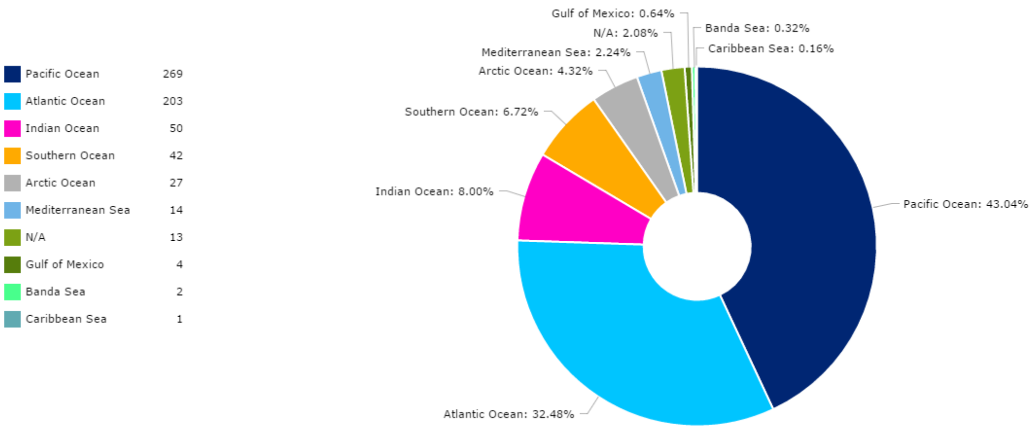


Fig. 63: Distribution of deployments for 2017, by basin

If we compare Fig. 63 to the intensity targets by basin (Table 1) we note that:

-the Atlantic Ocean is nearly over committed.

- the Southern Ocean is half committed.

- the Arctic Ocean is almost fully committed.
- the Indian Ocean is 30% committed, and Pacific Ocean is 70 % committed.

We note that the Banda Sea will see its first deployments and it is recalled that clearance are required for deployments directly into Indonesia EEZ.

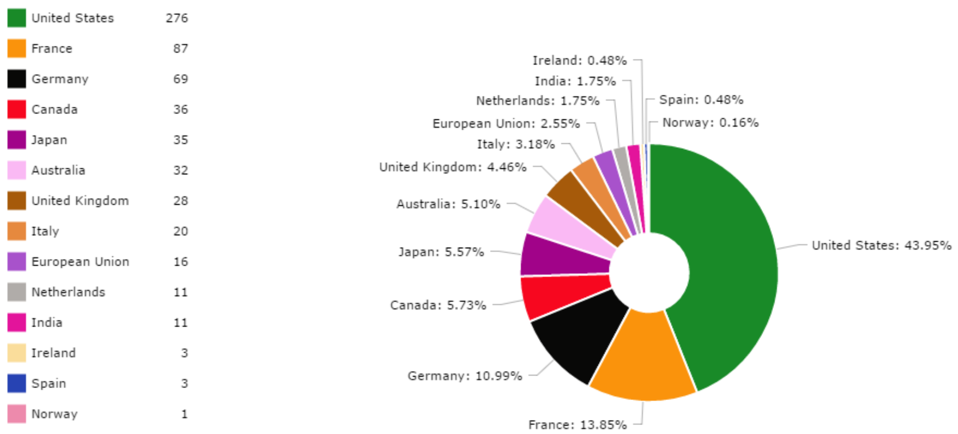


Fig. 64: Distribution of deployments for 2017, by country

We calculate and round up below (Table 9) the percentages of deployment per basin (2012-2016) to have a rough idea of national practices and priorities, and update the table with national commitments.

	TOTAL	AO	IO	PO	SO	Ar	Marginal	avg(YEAR)	2017*
AUSTRALIA	285		60%	30%	10%			57	**40**
CANADA	130	50%		50%				26	**47**
CHINA	232		30%	60%			10%	46	**45**
EU	53	50%				25%	25%	11	**100**
France	491	65%	10%	10%		5%	10%	98	**80**
GERMANY	302	65%			20%	10%	5%	60	**67**
INDIA	161		100%					32	**40**
ITALY	109	10%		20%	20%		50%	22	**35**
JAPAN	358			100%				72	*72*
KOREA	79			25%			75%	16	*16*
UK	186	75%	10%			15%		37	**40**
USA	2232	20%	15%	55%	5%		5%	446	**483**
NETHERLANDS	24	70%		30				5	**10**
SPAIN	19	25%					75%	4	**5**
FINLAND	17					40%	60%	3	3
GREECE	14						12	3	**5**
NORWAY	10	20%				80%		2	**3**
IRELAND	10	100%						2	**3**
OTHER (<10)	47	25%	10%	45%		10%	10%	9	
TOTAL	**4759**	**25%**	**20%**	**40%**	**5%**	**2%**	**8%**	**952**	**1099**
TARGET	**913**	**21%**	**18%**	**40%**	**8%**	**4%**	**6%**		

Table 9: Deployments vs Basins/Countries. Practices over 2012-2016.

We should first welcome the extra contribution from EU which will definitely push Argo forward in 2017. If we take last year values for the missing commitments (italic) about 1100 floats could be deployed in 2017. The reading of national reports offers as well exciting perspectives for the ramp up of the Chinese contribution.

Some anticipated national contributions are not fully planned including:

-100 floats from EU (deployed generally in Atlantic)
-45 floats from China (deployed 2/3 in Pacific but and 1/3 in Indian) or much more (see national report)
-10 from Canada (deployed 50/50 in Atlantic and Pacific)
-30 from India (deployed in Indian)
-15 from Italy (deployed half in Med Sea)
-12 from UK (deployed mainly in Atlantic)
-200 from USA (no plan for Indian Ocean yet)
-10 from Australia (generally in Indian 60%, Pacific 25%, and Southern)

So we can formulate some recommendations, with all the reserve required as numbers are being updated.

- ⇨ **Recommendation 23:** Atlantic Ocean implementers to consider planning deployments not yet registered, outside the Atlantic Ocean. With more than 200 units registered for 2017, and certainly a few ones to come from smaller programmes, the intensity target will be largely reached.
- ⇨ **Recommendation 24:** 100 EU floats could be used to fill gaps in Southern Ocean, to help address the anticipated decrease in the East and Equatorial Pacific and help to sustain the Indian Ocean.

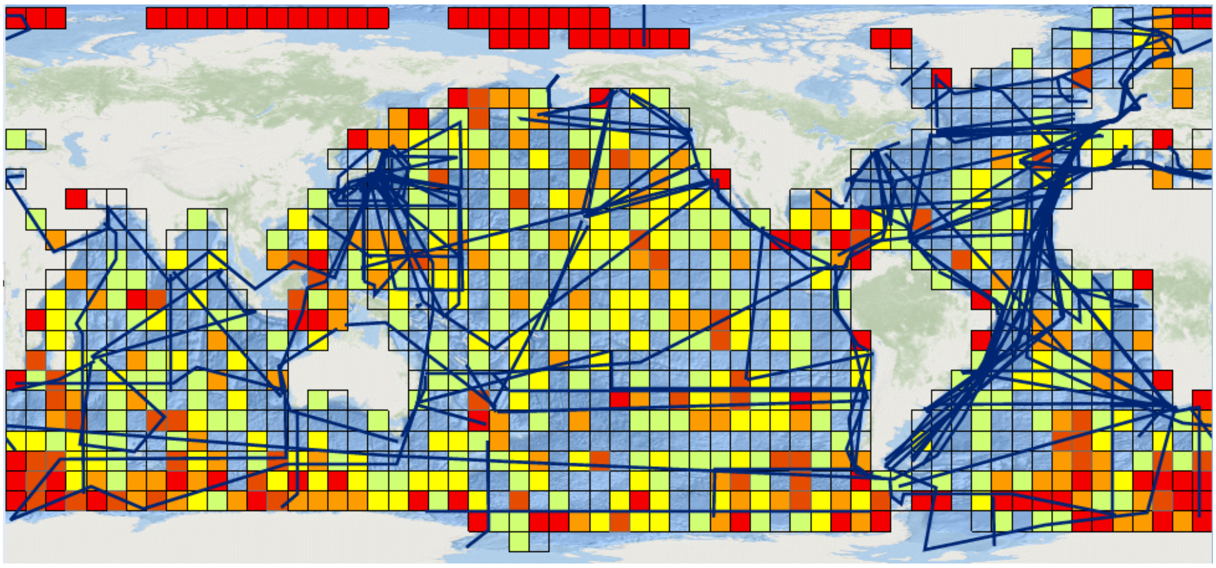


Fig. 65: Gaps and deployment opportunities

Fig. 65 provides a view on the remaining gaps and deployment opportunities. These are mainly academic cruises planned for 2017 and 2018. A substantial progress was made by the ship coordinator to compile these cruise plans and make them available in our system.

Deployment opportunities exposed above will not allow to fill all gaps, but for the first time we start to have a good information that should be exploited to the maximum, in particular for the few opportunities in the SO.

164 cruises, including 28 GO-SHIP cruises, including 40 of the most important research vessels from critical countries (GER, UK, FRA, US, ZA, AU, JP, IRE), mainly for 2017 and 2018 to 2019 were registered, including the geometry (cruise legs), which is a very difficult information to obtain in detail. The full list is provided in annex.

Users need to be logged in to see a number of "'private" cruises that we are not allowed to expose to the large public. As for floats, make a search on cruises (using e.g. departure date).
Argo operators can also register their cruises if they do not exist yet.
In any case, please contact the ship coordinator (mkramp@jcommops.org) to have more information on the cruises and point of contacts, and do not hesitate to send detailed requests for assistance to dpeloyments and retrieval, including timing, number of units, constraints, preferences, budget if any, etc. This can be done to recover deep or BGC floats, and prototypes as well.

- ⇨ **Recommendation 25:** Argo operators to send deployment or retrieval requests for 2017 to JCOMMOPS. A number of solutions will be provided in return. This is a service provided by the infrastructure, not fully exploited yet by the Argo community.

Here are the next steps for JCOMMOPS with regard to cruise plans management:

i) Get cruise information from other countries, e.g. Korea, China, Brazil.
ii) Automate procedure (machine to machine) where possible (UNOLS done)
iii) Get more precise route information
iv) Encourage cruise planners to submit to JCOMMOPS, or on JCOMMOPS website directly
v) Decrease privacy concerns
vi) … And renew this effort continuously

- ⇨ **Recommendation 26:** JCOMMOPS ship coordinator to participate in the working groups for basin implementation and planning

Synthesis

Argo is doing well but it remains fragile. Its core part is still underfunded.
If the deployments are dramatically slow down for a year due to industrial or technical issues, or any major budget cuts in national programmes, we have no much "reserve" to absorb the impact.

The instruments reliability (see annex) may offer some optimistic perspectives. Overall, reliability of main float models keeps improving. It is around 100-125 profiles that we see two groups of floats with diverging results (see table of performance in annex). The excellent performance of the SIO/WHOI/MRV floats deserved to be remarked. The mortality rate, for the global array, however increases in 2016 so it needs to be carefully monitored.
It is to be noted that some float experts and power users, have excellent performances.
The switch to Iridium is now clearly visible. In 2016, 80% of floats deployed use Iridium.

The multi-disciplinary evolution of the array, driven mainly through regional pilots, is not yet a reality that can weight sustainably in the overall result. At some point, it would be welcome to enhance the cooperation between these programmes and the core Argo partners. These extras contribution permits however to meet the requirements with regard to intensity of deployments globally, but the distribution is not appropriate to cover properly each basin (Pacific and Southern in particular).
Life expectancy of BGC floats is half of standard floats.

Anyway, the international cooperation is working very well so far for Argo. The sum of national contributions, practices and priorities is providing a well-balanced array. But the southern hemisphere has not many sponsors or deployment opportunities.

Two suggestions and take away messages can emerge from the list of recommendations piled in this report through the reading of various charts and maps, somehow repetitive:

i) Atlantic Ocean partners should contribute further outside the Atlantic Ocean.

ii) Southern Hemisphere can't be sustained efficiently without dedicated ship time.

We have seen in this report that an optimized spatial distribution can be obtained either through a higher intensity of deployments, or through dedicated ship time.
It would be interesting to compare the cost effectiveness of these two methods in depth, but a rough estimate shows that a large increase of floats and a light decrease of floats plus ship time produce the same effects (80% coverage indicator). So the latter seems apparently to be more cost effective. Organizing 10 arrangements for 10 units each or one arrangement for 100 has also an impact on staff resources, and increasing complexity of custom or shipping issues.

With stretched resources Argo must optimize its implementation and this can't be done without coordination, within core Argo programmes and with extras or new contributions. All float deployments that will fall under the Argo label must be notified in advance to comply with international regulations. Hence the planning exercise is not only mandatory but also critical to perform this optimization.

The Atlantic Ocean shows a very good status, in particular the North. A few gaps remain, in particular in the central south Atlantic. All indicators are green and the basin will be in good shape for the next years. An increased cooperation through the European infrastructure set up will certainly participate in improving the quality of the array. The deployment intensity could be however slow down, in the North in particular, to free up resources and address other challenges.

The Pacific Ocean is still in good shape, probably because of the good reliability of instruments and the careful planning, but considering the age of the array in most of the basin, the low intensity of latest deployments, the continuous lack of deployments every year, it may start to degrade if no major initiative is taken in 2017. Thankfully, the Kaharoa will come again rescue the global array but she can't fill all gaps alone. Ideally, near 500 floats should be deployed in the Pacific in 2017.
The Indian Ocean is fine but the intensity of deployment has been slightly low and irregular on average. Latest Karahoa deployments let us time to see, but it needs to be monitored carefully. The planning is uncompleted yet, and we don't know if the appropriate numbers of units will be deployed in 2017, i. e.: 100 units at least.
The Southern Ocean will certainly see its design finalized and all indicators will decrease. It needs

more commitments from AST members to have a chance to be completed and sustained. There is no significant improvement since we officially added this basin in our design. The deployment opportunities in this area need to be communicated widely to let a chance to any partner to contribute. JCOMMOPS will help in this regard.
If we consider as agreed the proposed extensions, the Southern Ocean needs at least 90 deployments in 2017 to progress but more would not hurt.
The Arctic Ocean, if its design is reviewed as suggested, may be just fine.
A number of expansions areas, such as Marginal Seas, can't be implemented without an expanded international support of coastal states. There are political issues with regard to EEZ access but moreover, there is a low interest from existing Argo partners to implement these areas.
Considering the Argo 2020 extensions, there is no much progress to note for WBC regions except for the Gulf Stream. The equatorial band is fine, except in the Atlantic, and living on the boost in Pacific a few years ago, and high intensity in north Indian Ocean.
The TPOS array, in its regular Argo design, was in very good shape but has started to decrease and is getting old. This will be accelerated if no appropriate deployments are planned in 2017. About 250 units should be deployed in TPOS in 2017.

Overall, there is still room for improvement for the global array. The tools provided in this report and on-line, and offered to the Argo community to monitor the array from many perspectives should encourage this improvement.
After a decade of operating a full array, and rounding the cape of the 4000 units, it may be the time for Argo partners, to move one step forward in the sustainability and cooperation. This can be done by developing an accurate deployment plans for 2017, by communicating across dedicated working groups, and evaluating the feasibility of funding dedicated ship time across whole basins and routinely, as a common resource, to optimize the array.
The JCOMMOPS office can definitely help to aggregate these efforts, and of course, to promote key deployment opportunities to fill gaps. This report provides a first set of recommendations in this regard. Thanks to the work of the Ship Coordinator, establishing gradually the necessary links with national focal points for academic cruise plans, but also with industry and civil society, we have a cess to cruise plans.
Opportunistic deployments will always be used as far as possible by the Argo teams, for the majority of deployments, but to balance and optimize the array we need dedicated charters. Charters usually deploy between 10 and 15% of the array already.
A base cost to keep in mind is 10 to 20% of the float price to deploy it anywhere in the ocean (2-4 times the shipping cost …), either through sailing or motor vessels.
At some point, the requirements may drive the logistics and not the opposite.

Finally, the perspectives offered by European and Chinese partners will certainly boost Argo beyond 4000 units soon and provide the necessary advance to secure and sustain our array.

References

AST #14 http://www.argo.ucsd.edu/Argo_Enhancements.pdf
AST #15 http://www.argo.ucsd.edu/Argo_Indicators_AIC.xlsx
AST #16 http://argo.jcommops.org/FTPRoot/Doc/Meetings/AST/16/Indicators.xslx
AST #17 http://www.argo.ucsd.edu/AIC_Coverage_Status.pdf

Most of the maps, statistics and indicators included in this report are available on http://argo.jcommops.org and routinely updated.

Annex 1: List of recommendations and actions

- ⇨ **Recommendation 1:** Review and feedback on the design for the Southern Ocean.
- ⇨ **Recommendation 2:** Potentially remove most of the central part of the Arctic Ocean
- ⇨ **Recommendation 3:** Confirm, and include TPOS2020 requirements in Argo 2020 Design.
- ⇨ **Recommendation 4:** define the floats sampling strategies that can or cannot be included in Argo Global
- ⇨ **Recommendation 5:** Monitor the mortality rate in other Marginal Seas. Double the intensity target in Mediterranean Sea (14 to 28 deployment per year) and potentially in all Marginal Seas.
- ⇨ **Recommendation 6:** Decide which target is appropriate for the coverage indicator (communication and cosmetic issue).
- ⇨ **Recommendation 7:** Confirm "Argo Global" and "Argo 2020" designs.
- ⇨ **Recommendation 7:** Improve the coordination concerning the deployment planning between Core, Equivalent, and BGC Argo as far as possible, to avoid overlaps.
- ⇨ **Recommendation 8:** Improve the regional coordination and planning for the Atlantic between EuroArgo, USA, and Canada.
- ⇨ **Recommendation 9:** Improve communication at the basin level for implementation plans, through working groups and teleconferences.
- ⇨ **Recommendation 10:** Increase cooperation around charted based deployment opportunities. One extra yearly cruises could be set to complete Karahoa's contribution and prepare the future.
- ⇨ **Recommendation 11:** Seek new national contributions, new partners and communicate on this need (ideally 200 floats per year are required: 100 for Pacific Ocean, 50 for Indian Ocean, 50 for Southern Ocean).
- ⇨ **Recommendation 13:** Use the Fig. 37 (Argo gaps) to plan and optimize next deployments for 2017

- ⇨ **Recommendation 14:** Increase the deployments in the Pacific Ocean in 2017 (order of 100 extra units, for a total of 487 floats).
- ⇨ **Recommendation 15:** Double the number of deployments in Southern Ocean
- ⇨ **Recommendation 16:** Review the potential partners for each Marginal Sea, as some doesn't seem to have regular and "core Argo" implementers.
- ⇨ **Recommendation 17:** Slowing down the rhythm of deployments in North Atlantic would not hurt.
- ⇨ **Recommendation 18:** A pause in deployments in North Indian Ocean would not hurt and priority should be given to the south region for 2017.
- ⇨ **Recommendation 19:** Double the intensity of deployments in South East Pacific (up to 125 in 2017)
- ⇨ **Recommendation 20:** Deploy at least about 250 units in the TPOS region to maintain the array and anticipate a 10% decrease in activity soon.
- ⇨ **Recommendation 21:** AST Members to provide yearly commitments i) by network (core, equivalent, BGC, deep) and ii) to distribute these commitments by basin..
- ⇨ **Recommendation 22:** (routine) AST Members to regularly check the AIC/JCOMMOPS website and work with the TC to ensure the planning information is correct and up to date.
- ⇨ **Recommendation 23:** Atlantic Ocean implementers to consider planning deployments, not yet registered, outside the Atlantic Ocean. With more than 200 units registered for 2017, and certainly a few ones to come from smaller programmes, the intensity target will be largely reached.
- ⇨ **Recommendation 24:** 100 EU floats could be used to fill gaps in Southern Ocean, to help address the anticipated decrease in the East and Equatorial Pacific, and help to sustain the Indian Ocean.
- ⇨ **Recommendation 25:** Argo operators to send deployment or retrieval requests for 2017 to JCOMMOPS. A number of solutions will be provided in return. This is a service provided by the infrastructure, not fully exploited yet by the Argo community.
- ⇨ **Recommendation 26:** JCOMMOPS ship coordinator to participate in the working groups for basin implementation and planning

- ⇨ **Action 1:** (JCOMMOPS): update the "Global Argo" and "Argo 2020" designs accordingly, and recalculate all concerned targets and performance indicators.
- ⇨ **Action 2:** (JCOMMOPS) to review the list of equivalent and BGC programmes with AST members.
- ⇨ **Action 3:** (JCOMMOPS) Develop indicators for sub-basins

Annex 2: AST#17 Action Items

Action 3: AIC Funding: A 3 years grant from the government of Canada has just been accepted (15k$ CA / year). See agenda item.

Action 6: National Focal Points. The IOC is about to send a new circular letter for a global update of national focal points. TC drafted the letter.

Action 8: Contacts points for cruise plans. Only a few AST members provided the contact points to the ship coordinator.

Action 15: WBC definition. Fixed.

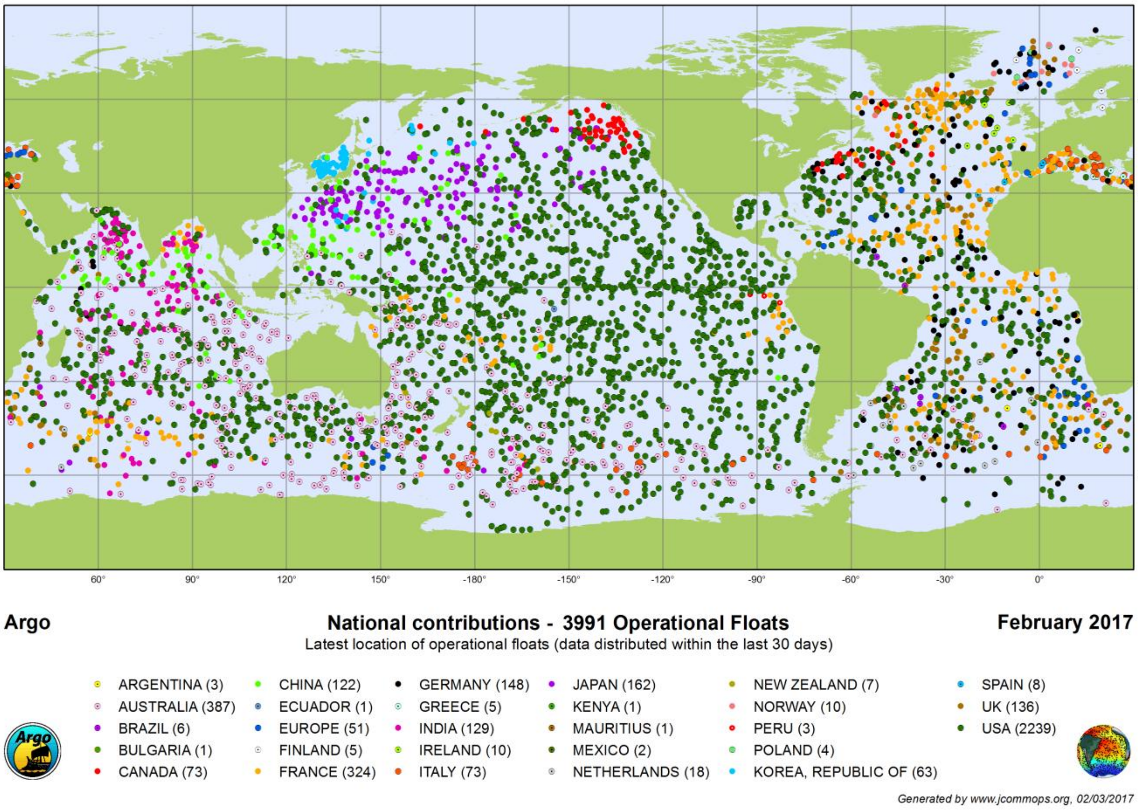
Action 17: Map the present “global domain”. All “products” adapted as appropriate just after AST17. Improvements possible after better defining the “Argo Networks”.

Action 21: Status map on AST homepage is plugged in near real time on AIC index files. It is possible to exploit the different networks to highlight core, equivalent, BGC and deep contributions.

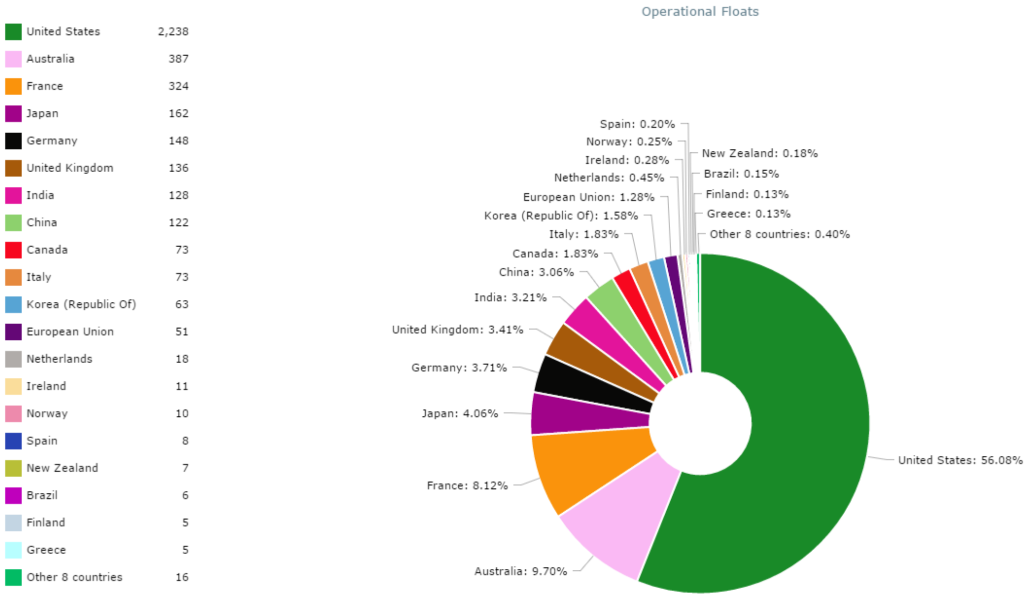
Action 24: Participation to the new brochure design. See agenda item.

Annex 4: Statistics & Maps

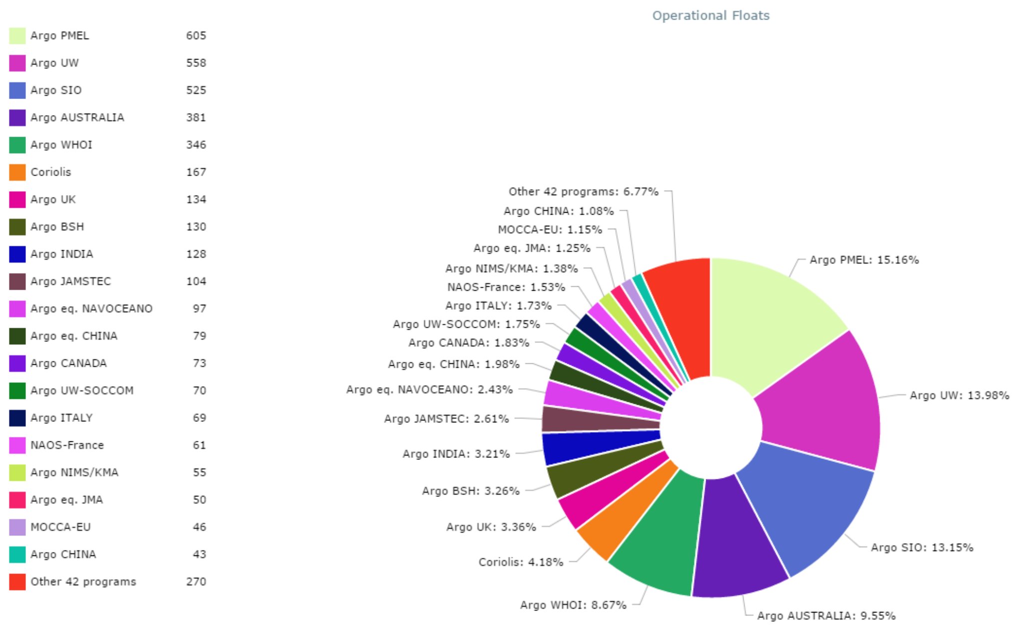
Operational Floats



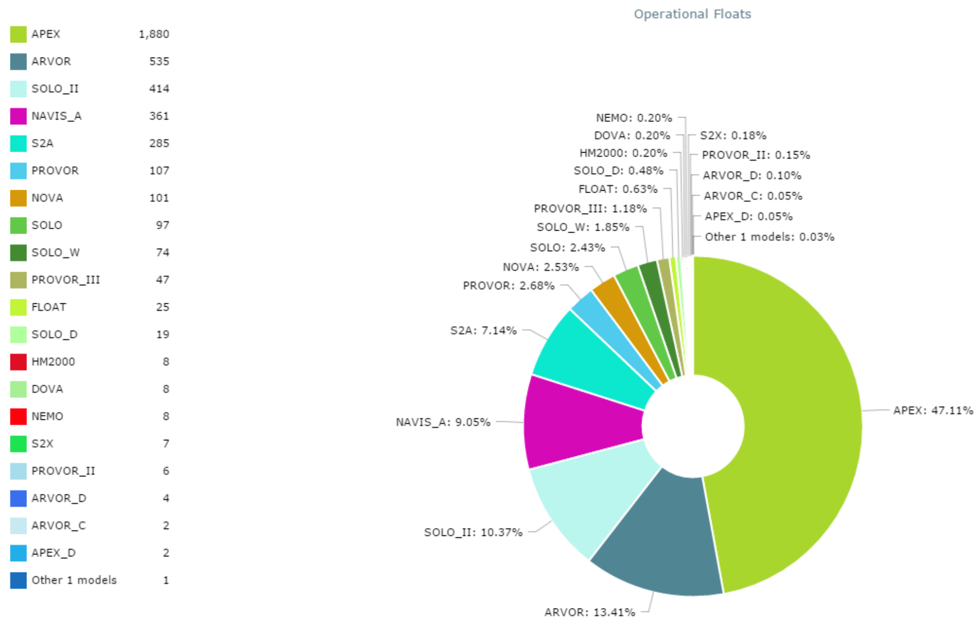
Operational Floats, by country, as of February 2017



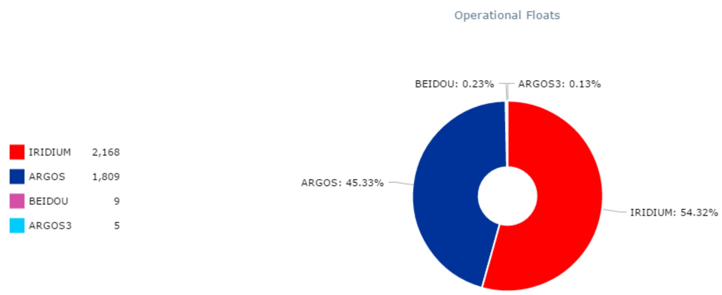
Operational Floats, by country, as of February 2017



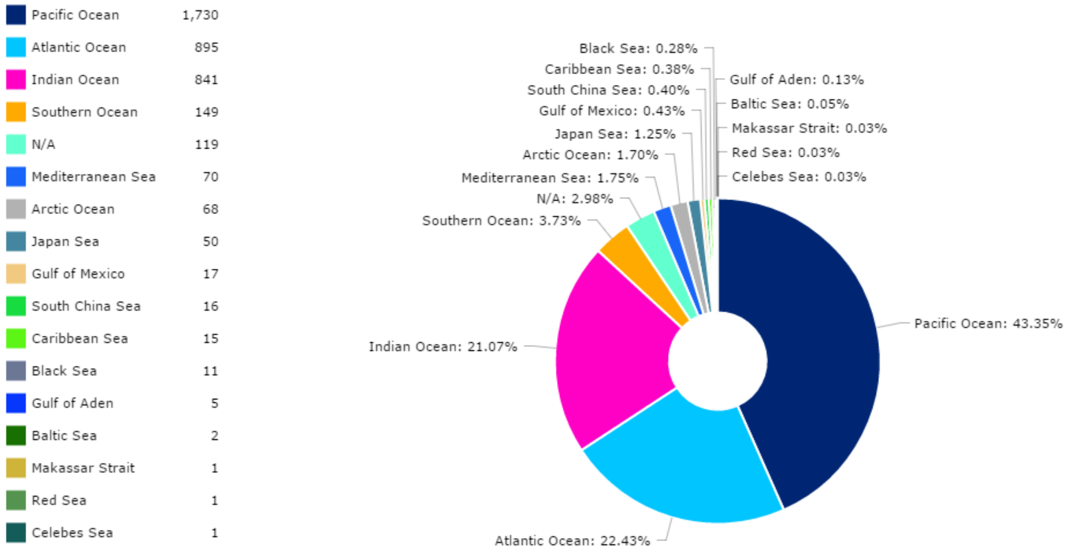
Operational Floats, by program, as of February 2017



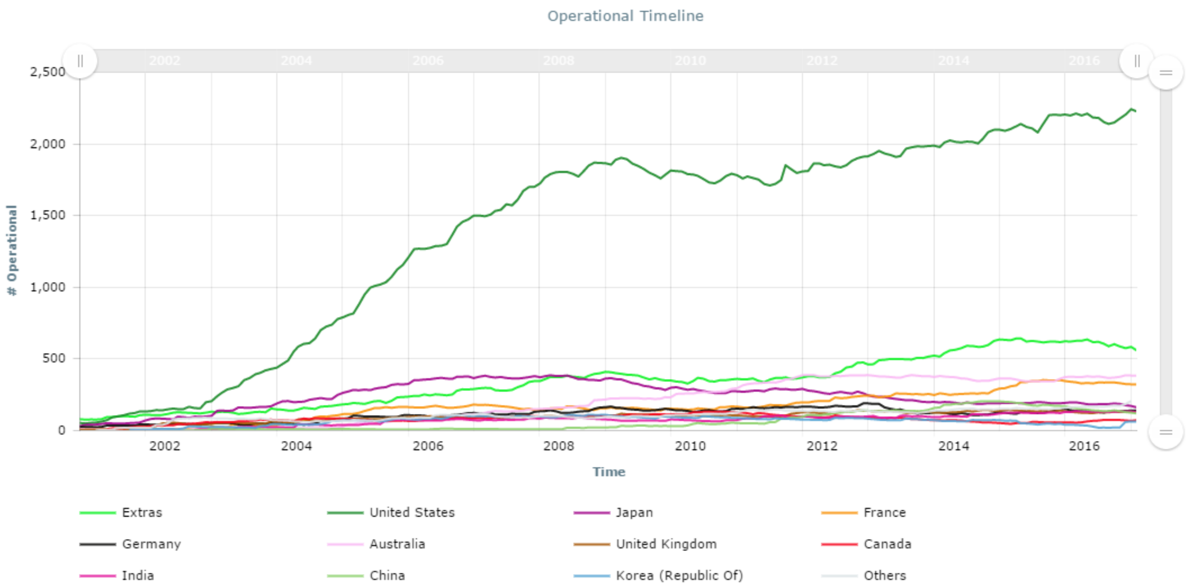
Operational Floats, by model, as of February 2017



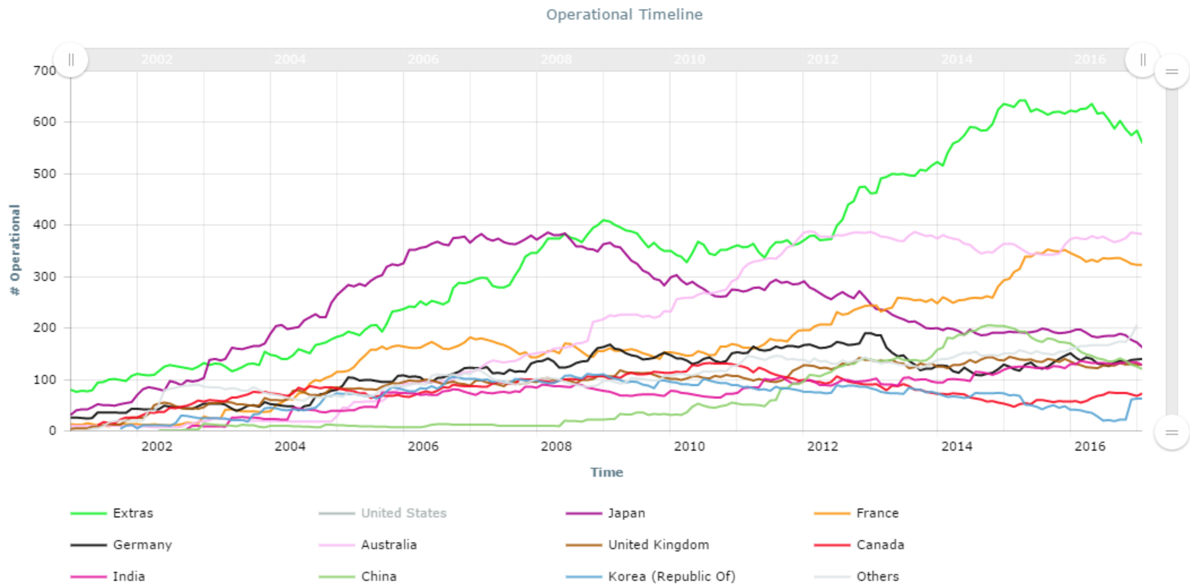
Operational Floats, by telecommunication type, as of February 2017



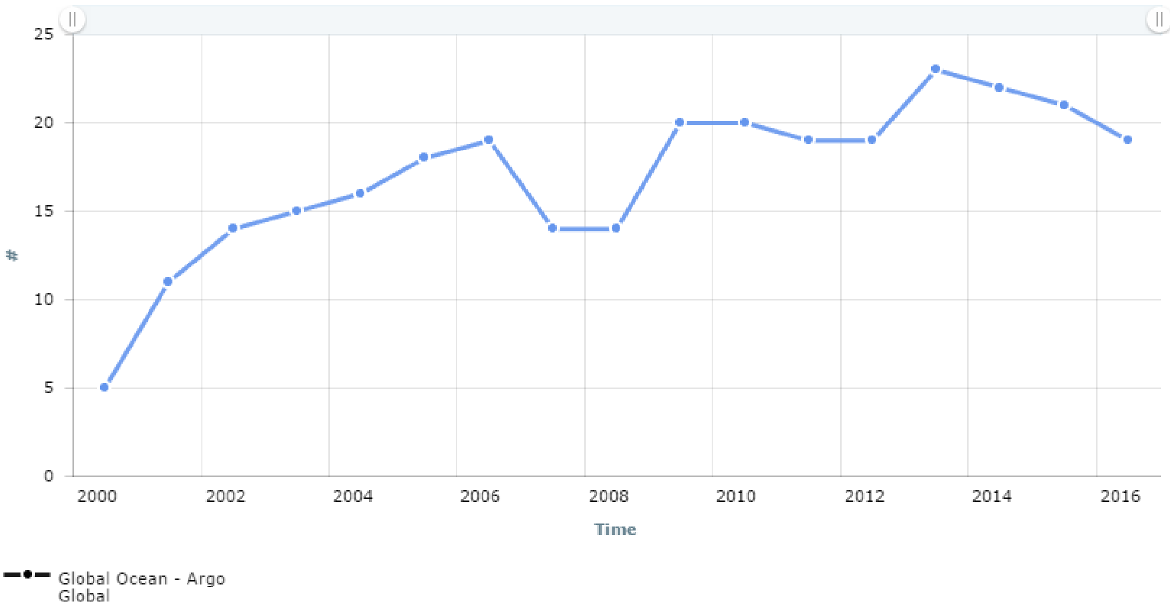
Operational Floats, by basin, as of February 2017



Monthly distinct floats distributing profiles, by country. “Extras” includes equivalent and BGC.



Monthly distinct floats distributing profiles, by country. "Extras" includes equivalent and BGC. USA hidden.



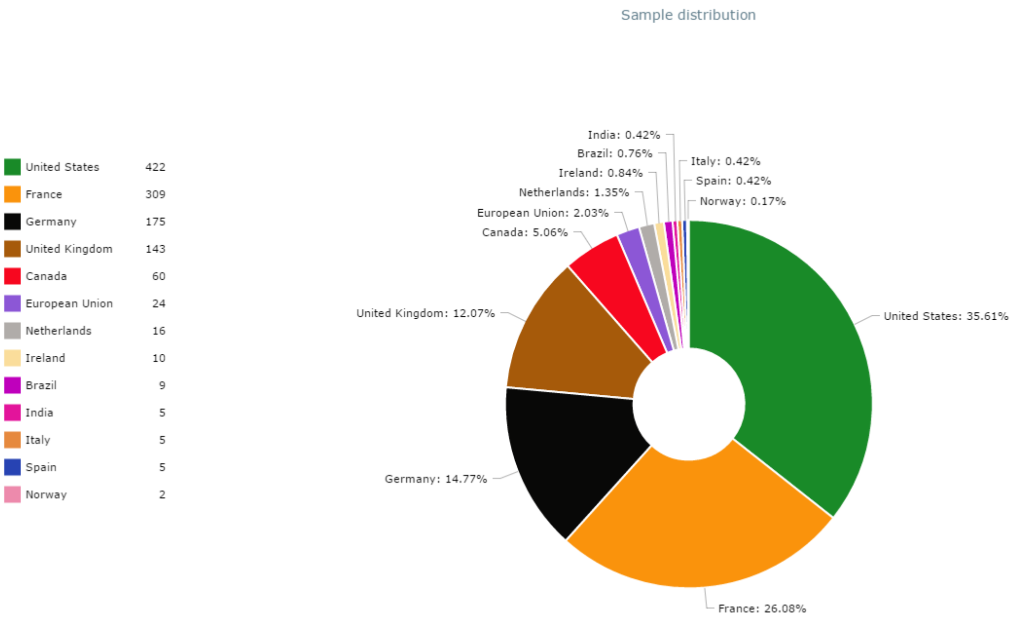
Active Countries (deploying floats the considered year)

Deployments

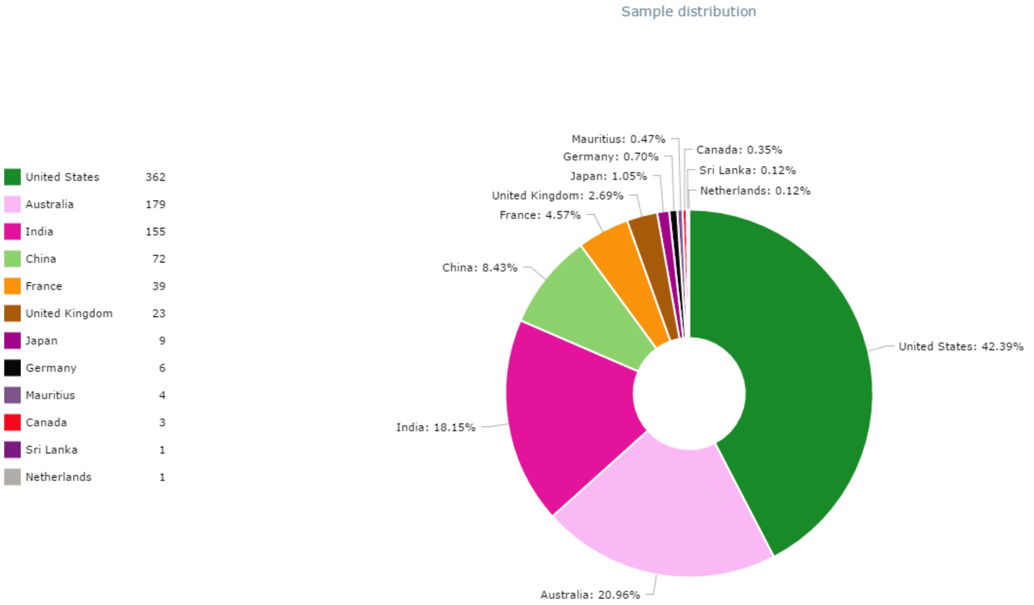
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
- Total -	**297**	**454**	**673**	**866**	**1016**	**932**	**752**	**900**	**541**	**836**	**950**	**1016**	**878**	**1056**	**920**	**883**
United States	129	150	315	442	513	517	424	434	246	388	374	467	416	466	440	436
Australia	0	12	8	4	63	46	43	76	35	79	120	49	64	45	52	75
France	9	8	34	85	89	51	36	90	35	59	64	105	89	108	131	57
Japan	40	76	128	118	108	116	102	92	74	90	132	90	80	96	41	51
Germany	21	14	28	42	57	36	35	71	33	62	54	76	45	61	76	44
European Union	15	70	4	20	27	20	8	0	0	0	2	0	5	9	4	36

United Kingdom	29	38	37	45	28	24	33	29	20	25	39	38	35	47	32	34
Canada	30	38	31	30	28	38	18	25	23	28	17	27	33	9	28	33
India	1	11	23	30	45	15	31	15	7	23	44	34	27	44	27	29
Italy	0	0	0	0	0	0	0	0	0	2	2	19	13	24	27	27
China	0	5	16	8	0	6	0	16	16	32	49	68	30	91	19	24
Korea (Republic Of)	16	25	33	31	38	33	9	29	17	12	14	14	17	15	17	16
Peru	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Netherlands	0	0	0	3	4	4	4	13	4	9	7	7	4	8	2	3
Ireland	0	0	2	0	0	0	0	4	4	3	3	2	1	2	2	3
Finland	0	0	0	0	0	0	0	0	0	2	2	3	4	5	2	3
Greece	0	0	0	0	0	0	0	0	0	1	0	0	1	5	5	3
Norway	0	3	6	0	0	2	0	0	0	4	0	0	2	6	0	2
Poland	0	0	0	0	0	0	0	0	2	2	0	1	0	0	3	2
Spain	0	0	7	2	1	1	0	0	0	12	18	9	2	6	1	1
New Zealand	2	2	0	2	1	3	2	2	2	2	2	2	2	0	4	0
Brazil	0	0	0	0	4	0	4	0	10	0	0	0	0	2	7	0
Argentina	0	0	0	0	0	12	0	0	0	0	0	4	0	0	0	0
Mauritius	0	0	1	2	0	2	0	0	0	0	4	0	2	2	0	0
Chile	0	0	0	0	4	4	0	4	0	0	0	0	0	0	0	0
Turkey	0	0	0	0	2	2	0	0	0	0	0	0	4	2	0	0
Mexico	0	0	0	0	2	0	0	0	1	0	0	0	0	3	0	0
Russian Federation	0	2	0	2	0	0	0	0	2	0	0	0	0	0	0	0
Denmark	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kenya	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0
Bulgaria	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0
Ecuador	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
Gabon	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
Costa Rica	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
South Africa	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Lebanon	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Saudi Arabia	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Sri Lanka	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0

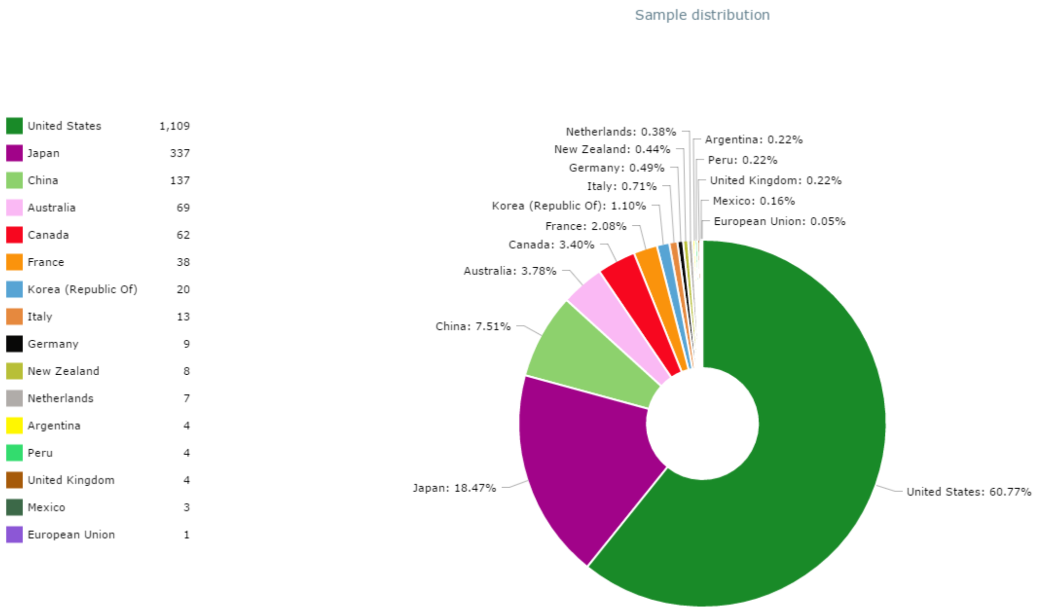
Deployments per country



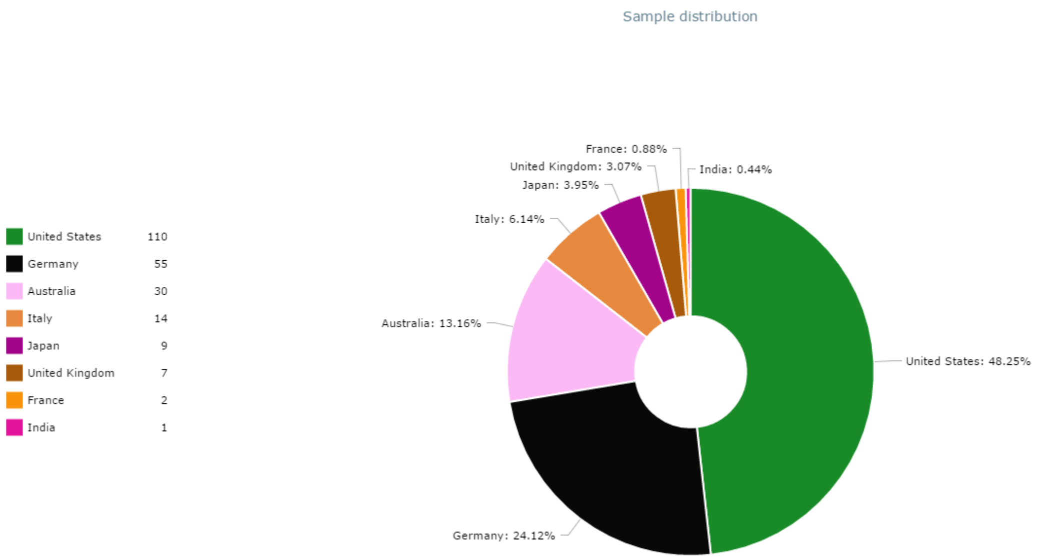
Deployments in Atlantic Ocean 2012-2016, by national programme.



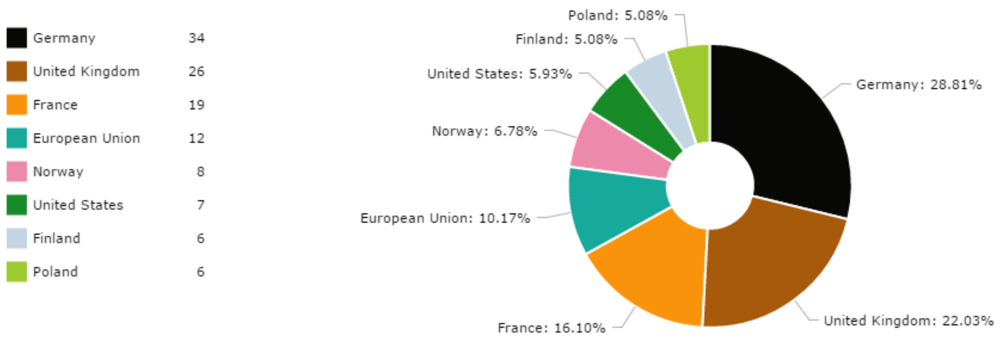
Deployments in Indian Ocean 2012-2016, by national programme.



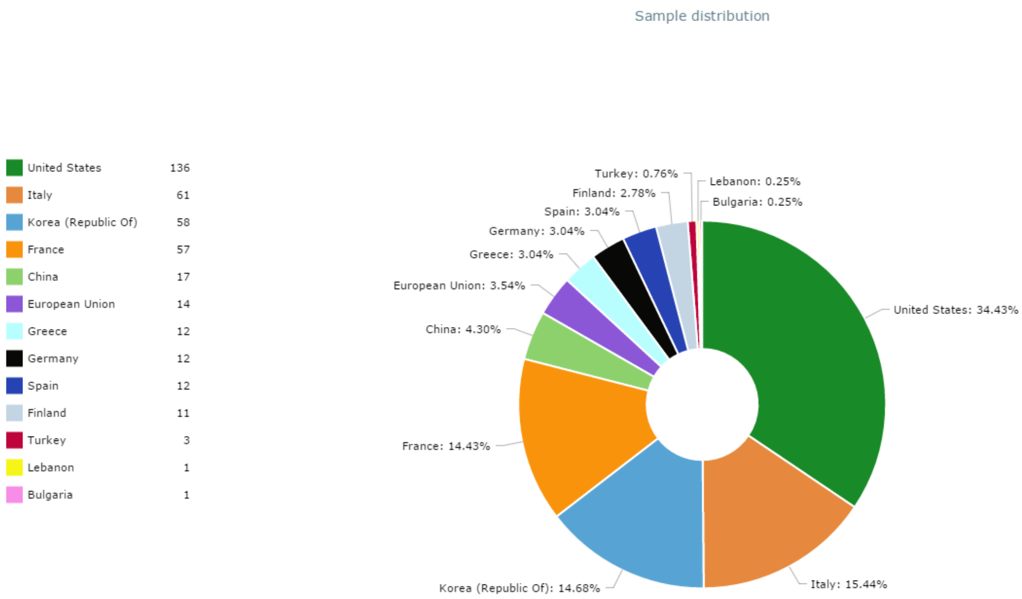
<u>Deployments in Pacific Ocean 2012-2016, by national programme.</u>



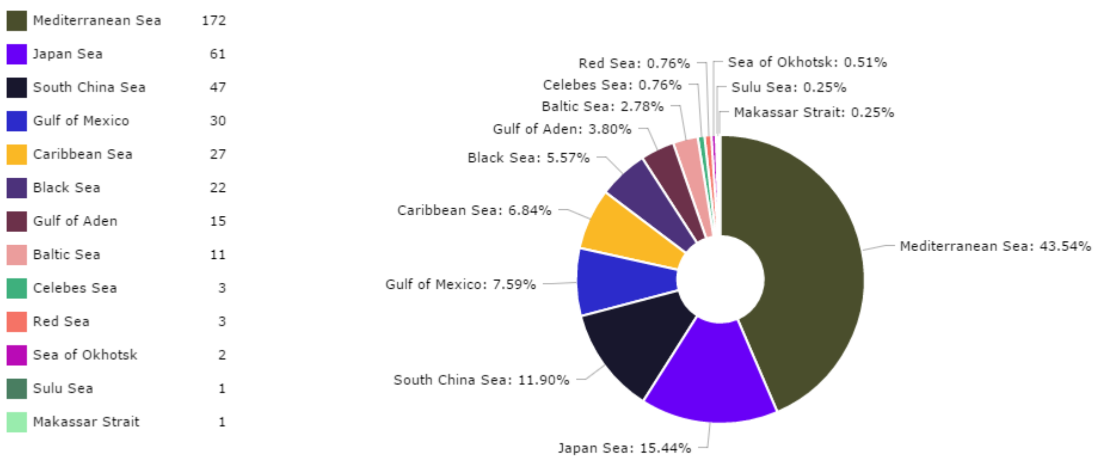
<u>Deployments in Southern Ocean 2012-2016, by national programme.</u>



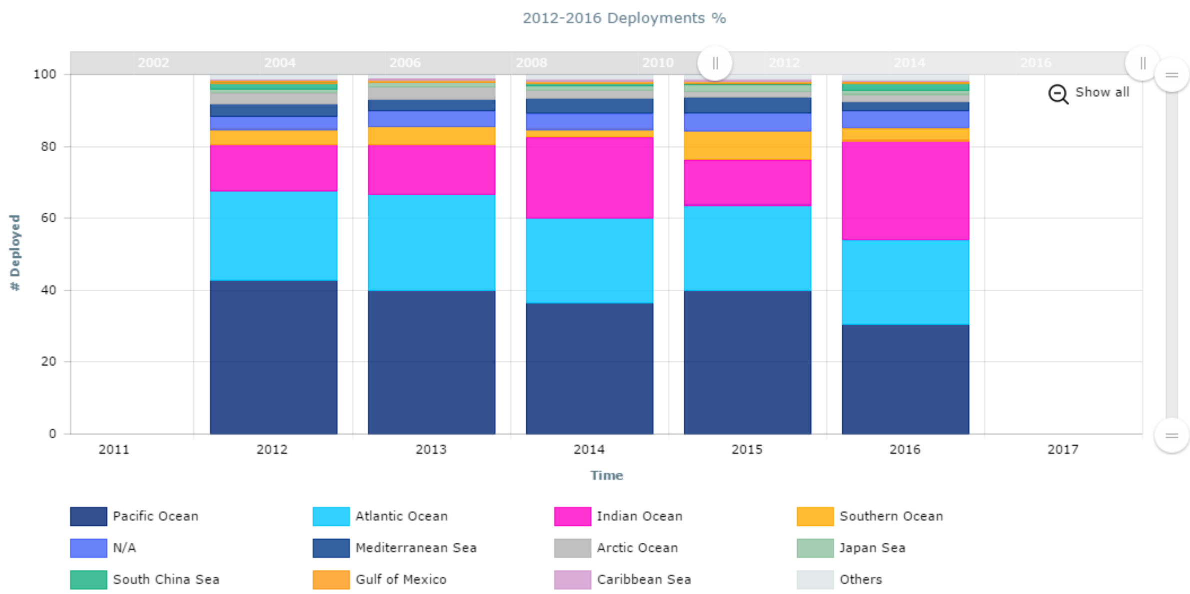
Deployments in Arctic Ocean 2012-2016, by national programme.



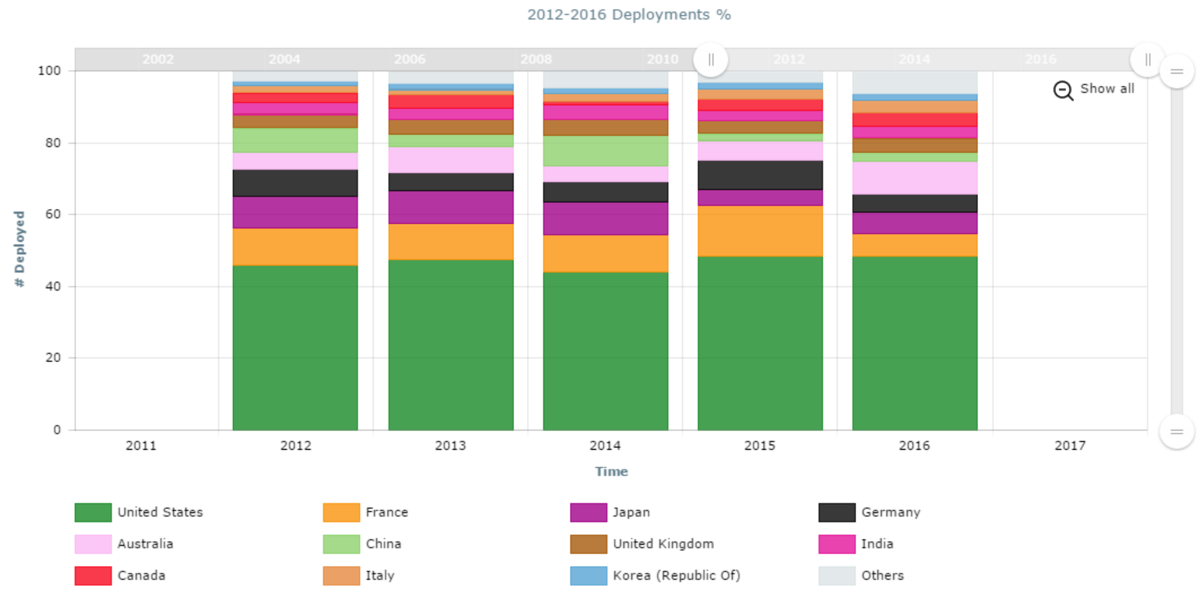
Deployments in Marginal Seas 2012-2016, by national programme.
The US contribution is 20% WHOI and 80% NAVO.



Deployments in Marginal Seas 2012-2016



Deployments by basin 2012-2016



Deployments by country 2012-2016

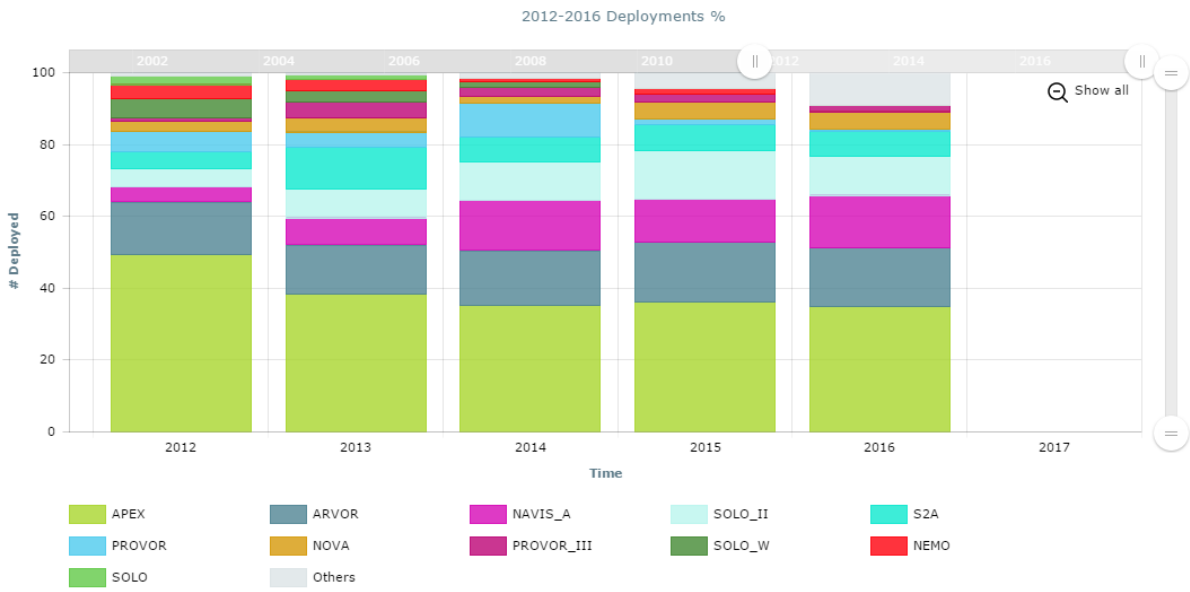
KAHAROA (ICES Code: 61LY)	Research Vessels	556
RONALD H. BROWN (ICES Code: 33RO)	Research Vessels	158
JAMES CLARK ROSS (ICES Code: 74JC)	Research Vessels	134
NATHANIEL B. PALMER (ICES Code: 3206)	Research Vessels	125
S.A. AGULHAS II (ICES Code: 91AH)	Research Vessels	96
RYOFU MARU (ICES Code: 49UP)	Research Vessels	90
SAGAR NIDHI	Research Vessels	89
HUDSON (ICES Code: 18HU)	Coastguard	86
ROGER REVELLE (ICES Code: 33RR)	Research Vessels	77
INVESTIGATOR (ICES Code: 096U)	Research Vessels	74
METEOR (ICES Code: 06M3)	Research Vessels	71
AURORA AUSTRALIS (ICES Code: 09AR)	Research Vessels	69
KEIFU MARU	Unknown	67
POLARSTERN (ICES Code: 06AQ)	Research Vessels	66
MIRAI (ICES Code: 49NZ)	Research Vessels	62
BLUE FIN (ICES Code: 331I)	Support vessels	60
KILO MOANA (ICES Code: 33KB)	Research Vessels	58
ARAON	Icebreaking vessels	57
MAERSK VILNIUS (ICES Code: SIMV)	Unknown	57
THOMAS G. THOMPSON (ICES Code: 3250)	Research Vessels	53
KNORR (ICES Code: 316N)	Research Vessels	52
MELVILLE (ICES Code: 318M)	Research Vessels	52

Key 2012-2016 ships, #Deployments.

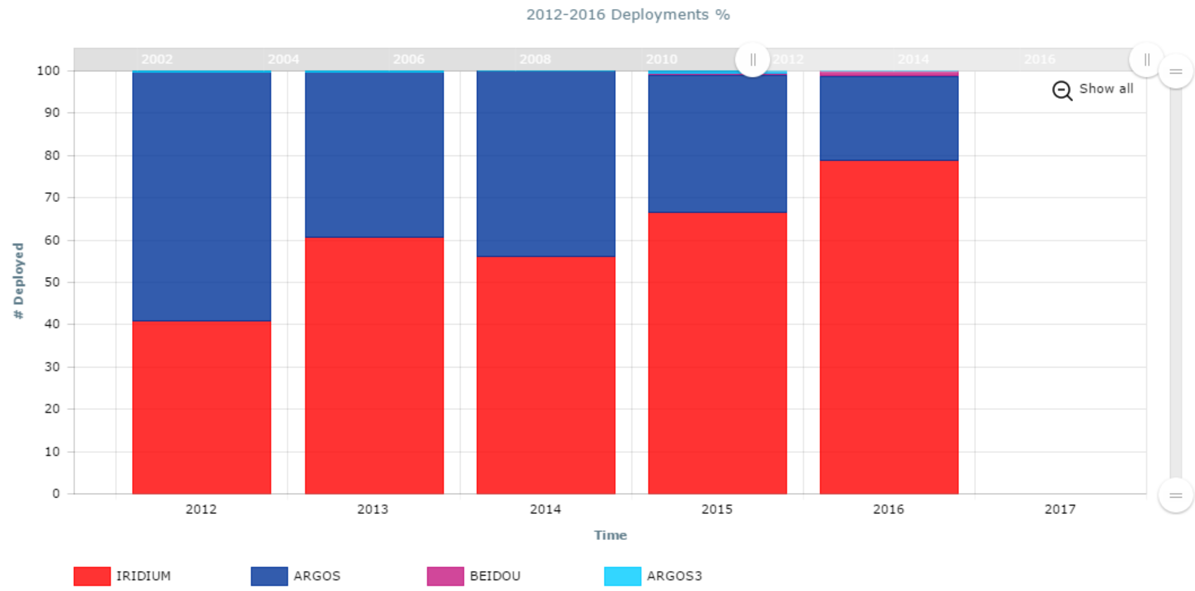
KAHAROA (ICES Code: 61LY)	Research Vessels	143
INVESTIGATOR (ICES Code: 096U)	Research Vessels	69
ROGER REVELLE (ICES Code: 33RR)	Research Vessels	49
METEOR (ICES Code: 06M3)	Research Vessels	33
HUDSON (ICES Code: 18HU)	Coastguard	25
RONALD H. BROWN (ICES Code: 33RO)	Research Vessels	21
SIKULIAQ (ICES Code: 33BI)	Research Vessels	20
JAMES CLARK ROSS (ICES Code: 74JC)	Research Vessels	19
KEIFU MARU (ICES Code: 49UF)	Research Vessels	17
AURORA AUSTRALIS (ICES Code: 09AR)	Research Vessels	15
BRAVEHEART	Research Vessels	15
S.A. AGULHAS II (ICES Code: 91AH)	Research Vessels	15
SARMIENTO DE GAMBOA (ICES Code: 29AH)	Research Vessels	15
BLUE FIN (ICES Code: 331I)	Support vessels	13
DISCOVERY (ICES Code: 74EQ)	Research Vessels	13
MAERSK VILNIUS (ICES Code: SIMV)	Unknown	13
Sagar Kanya (ICES Code: 41SG)	Research Vessels	12
ZIMIC	Military ships	12
MIRAI (ICES Code: 49NZ)	Research Vessels	11
SINDHU SADHANA	Research Vessels	11
HONGDAESUN	Military ships	10
JOHN P. TULLY (ICES Code: 18DD)	Coastguard	10

Key 2016 ships, #Deployments.

Instrumentation



2012-2016 Deployments, float models (%)

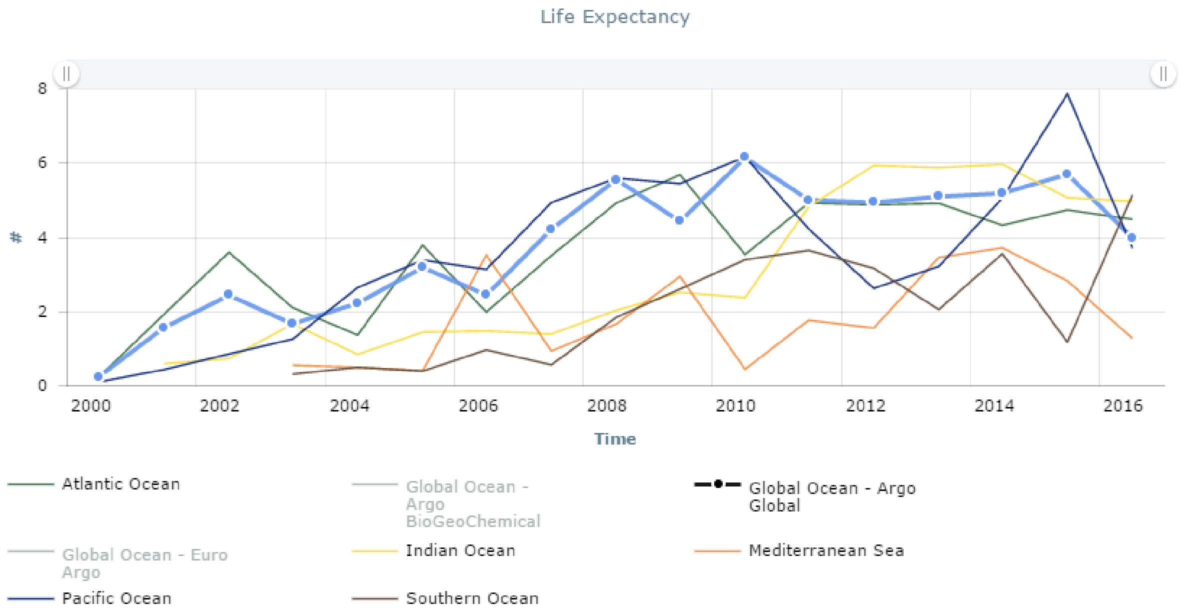


2012-2016 Deployments, telecom. types (%)

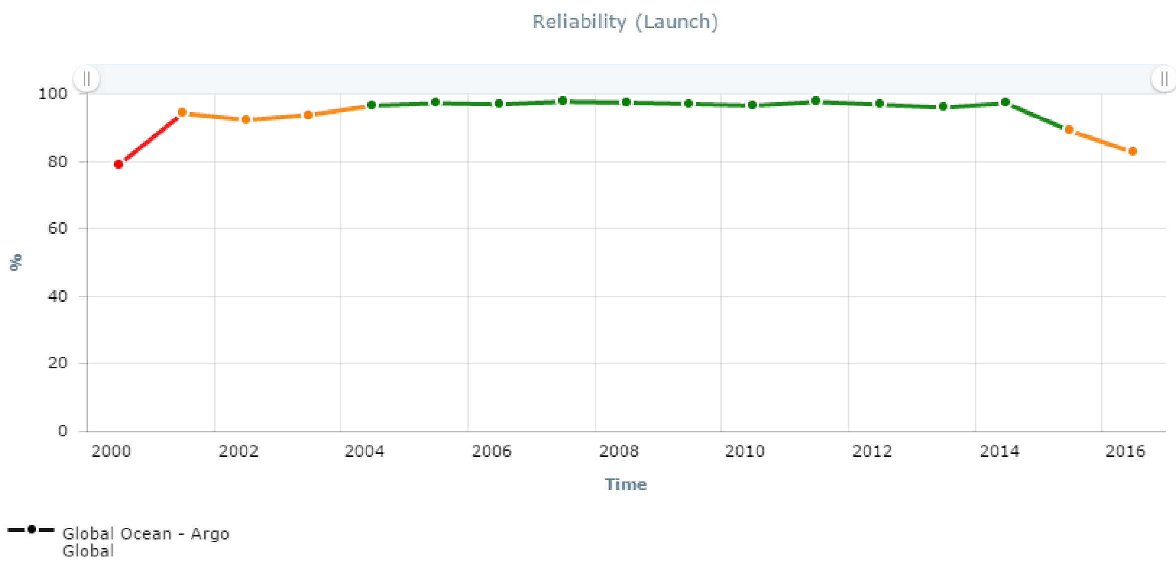
Instrumentation

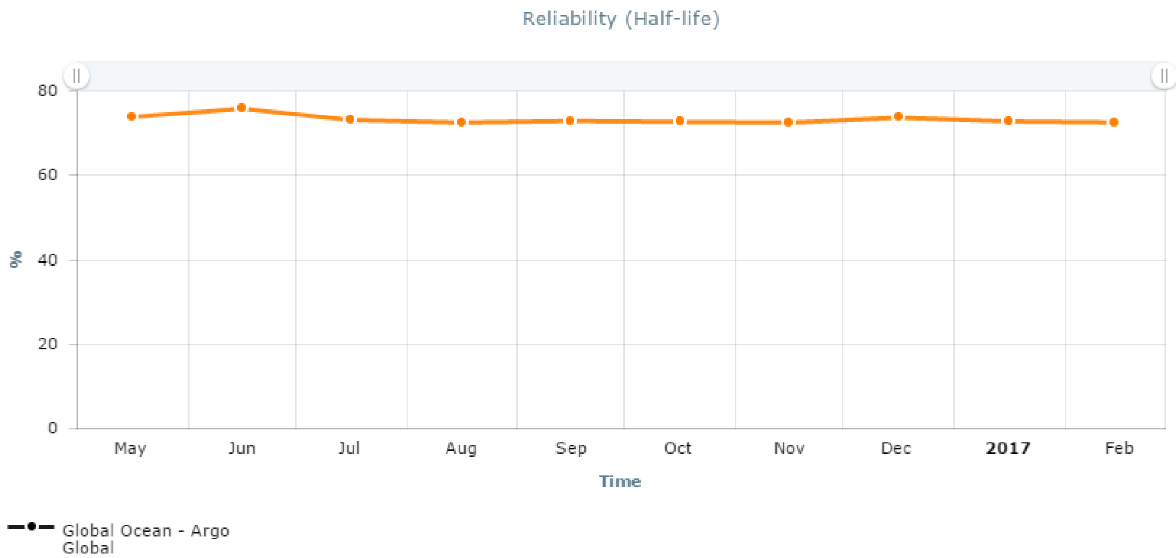
Life Expectancy Argo Global	3.99 2016	No Target	Annual Life expectancy calculation based on demographic studies
Mortality Rate Argo Global	25.58% 2016	No Target	The mortality rate, or death rate, is the ratio between the yearly failures and the average float population that year (monthly) - Global
Reliability (Full) Argo Global	37.6% 2/2017	75% Target	% of deployment surviving 150 cycles
Reliability (Half Life) Argo Global	72.54% 2/2017	90% Target	% of deployment surviving 75 cycles
Reliability (Launch) Argo Global	82.68% 2016	95% Target	% of deployment surviving one cycle over last calendar year deployments

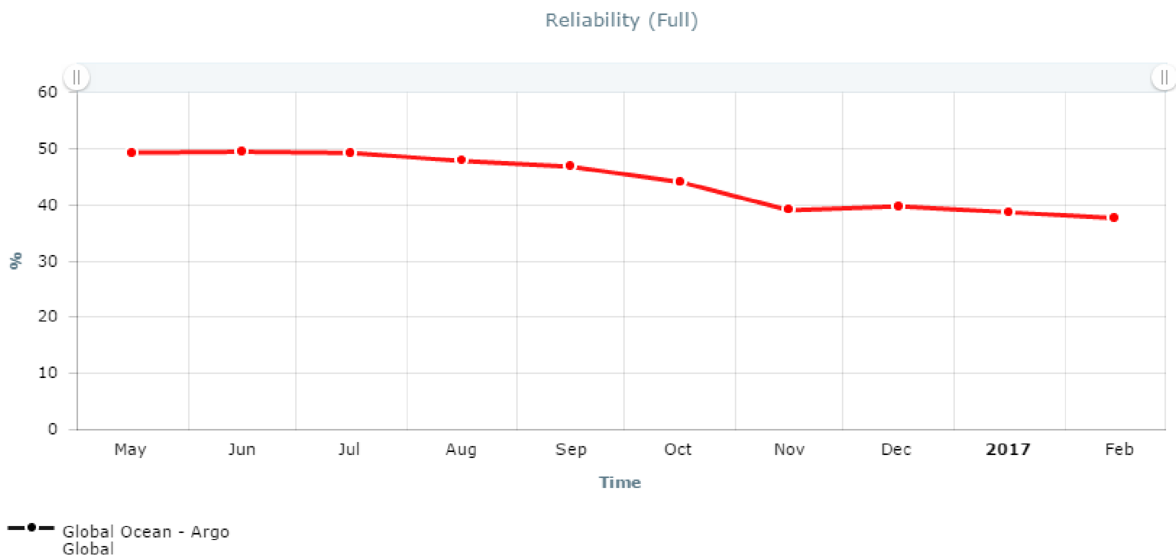
KPIs for Instrumentation



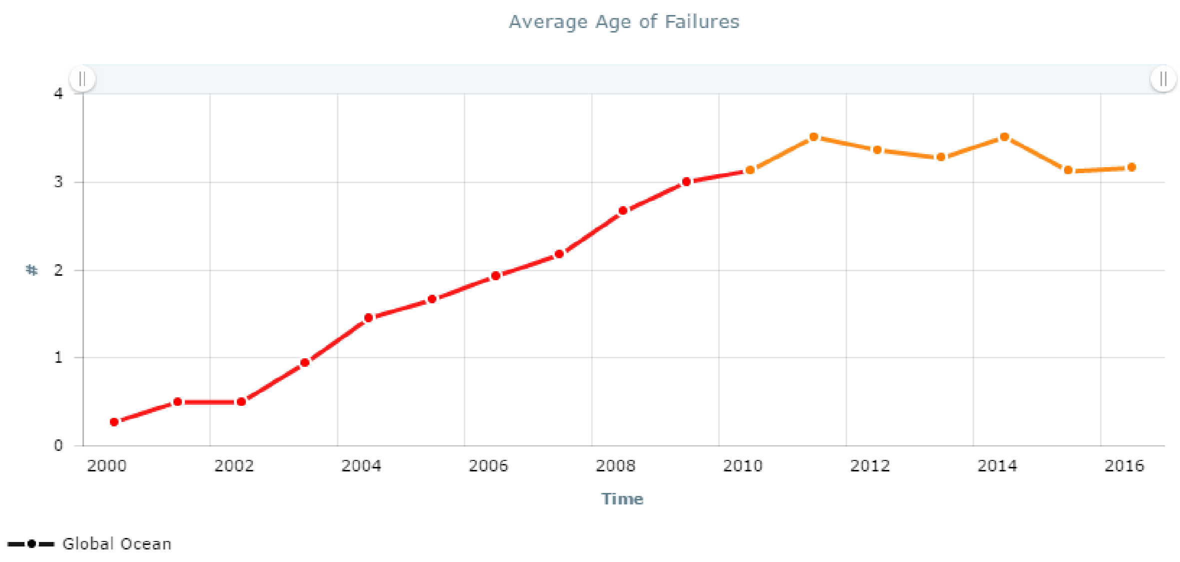
Life Expectancy, by year, for different basins



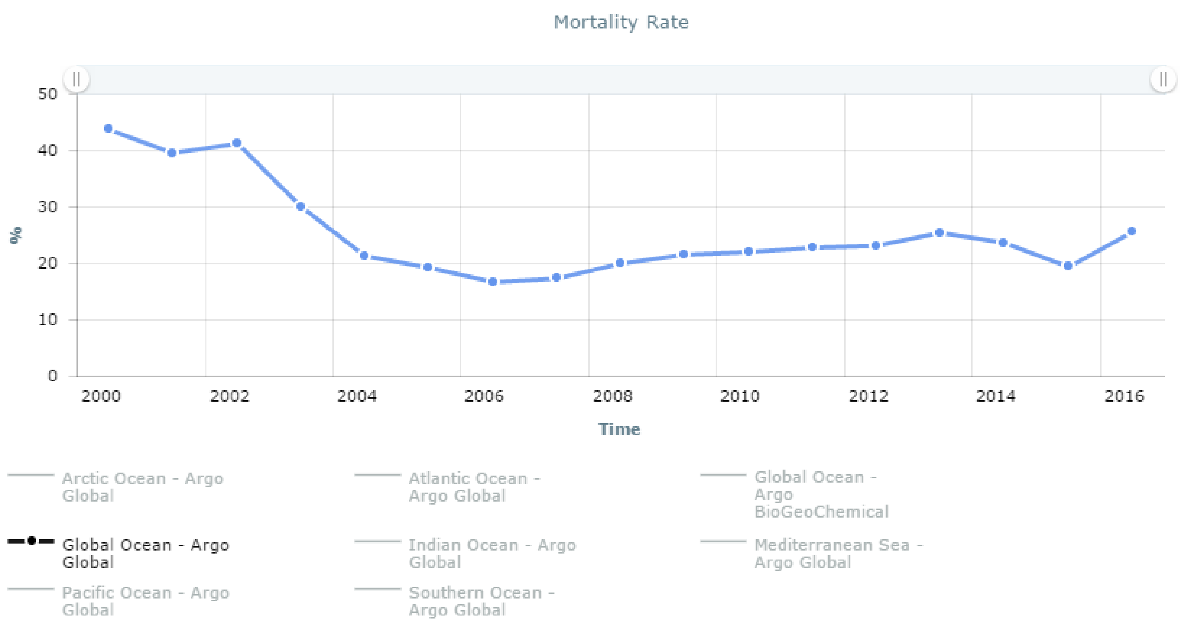




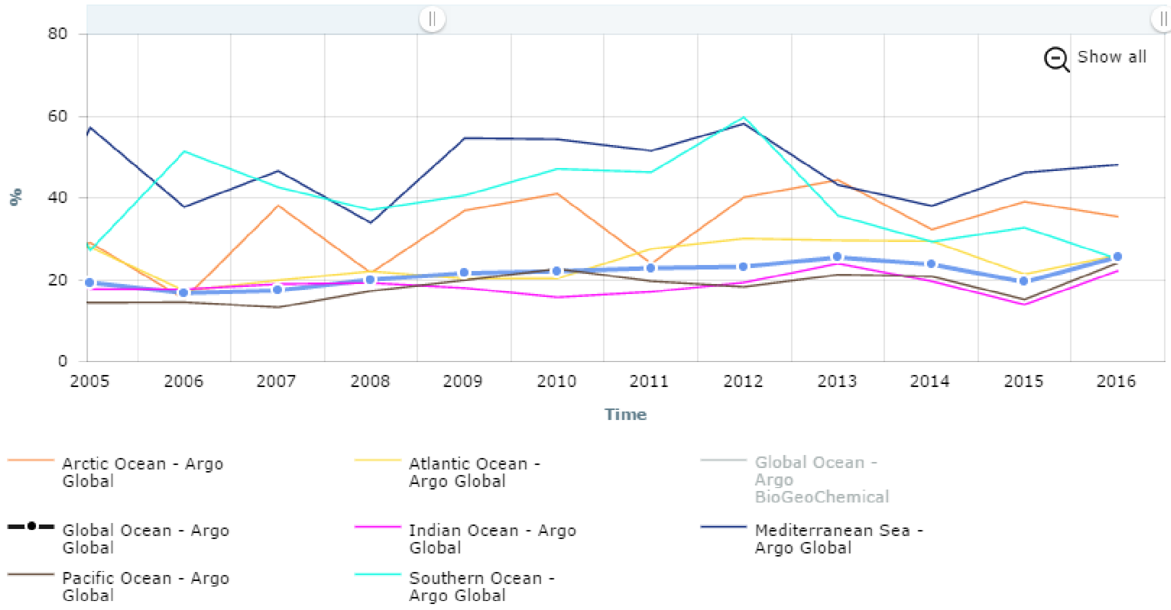
% of floats distributing 0, 75, 150 profiles



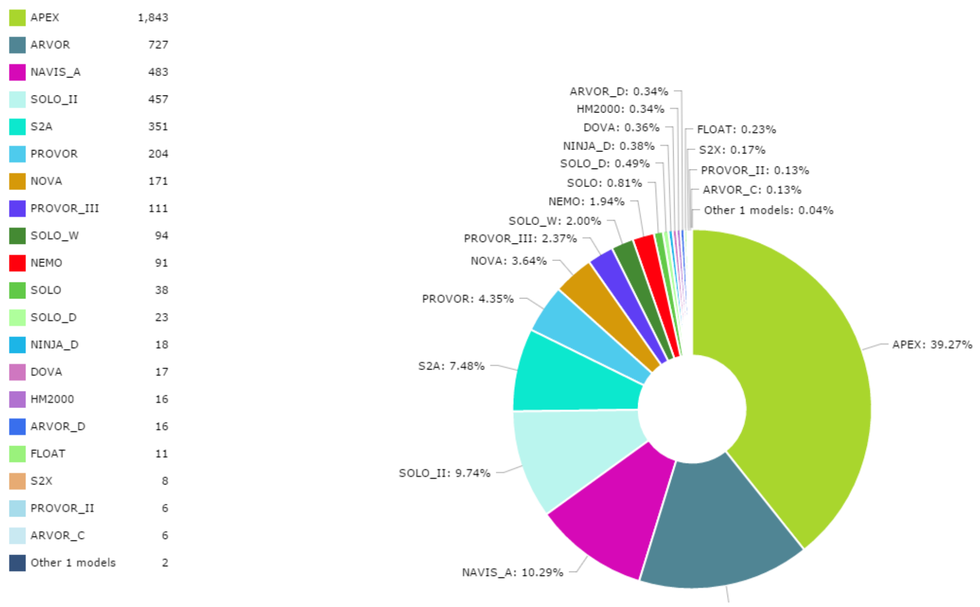
Average Age of failures



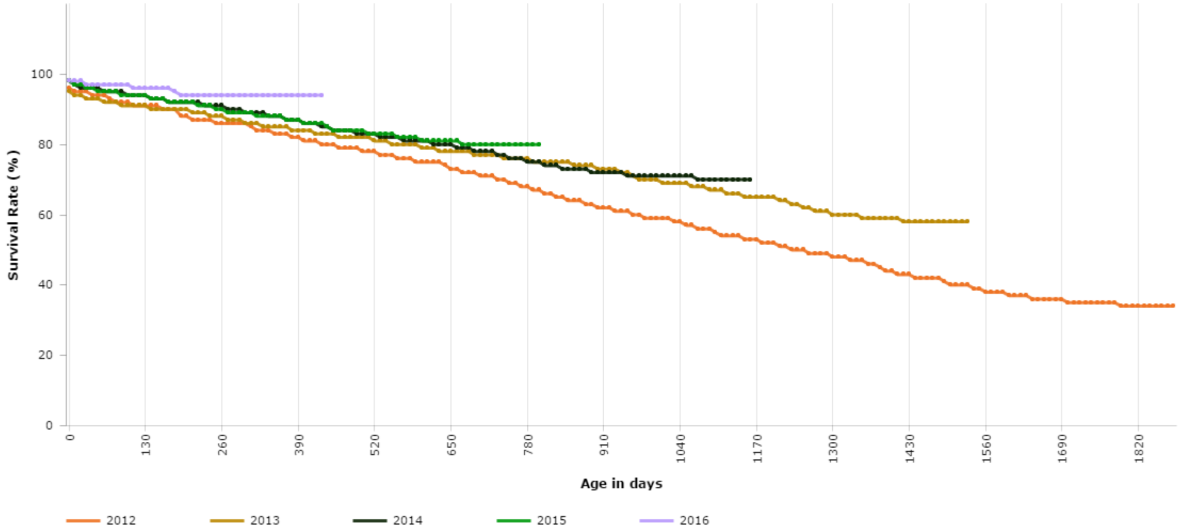
Mortality Rate (Global Argo)



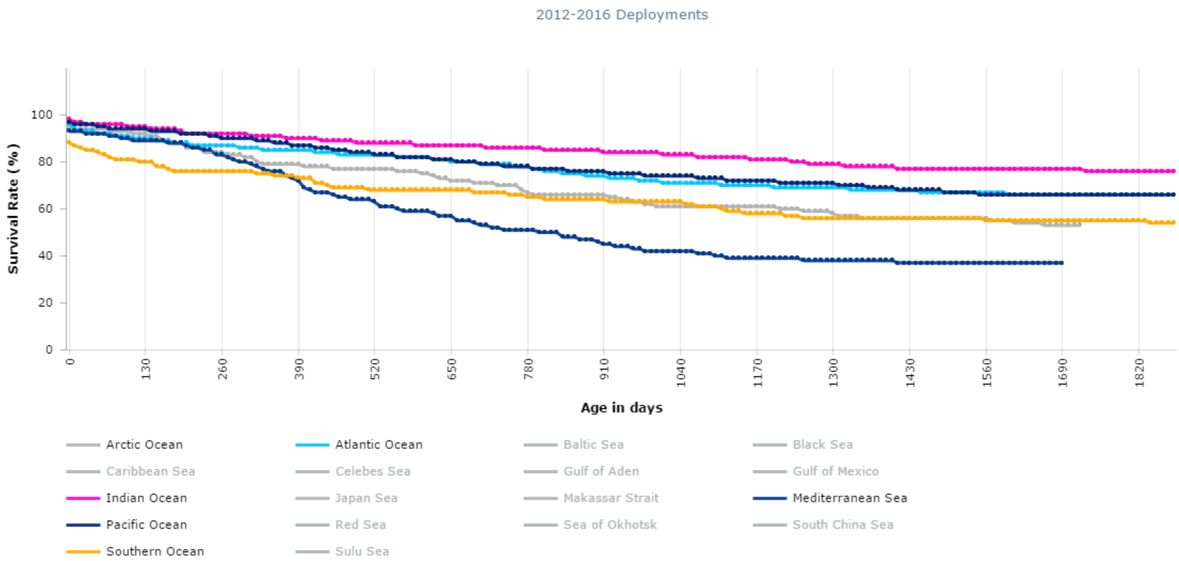
Mortality Rate, by deployment basin



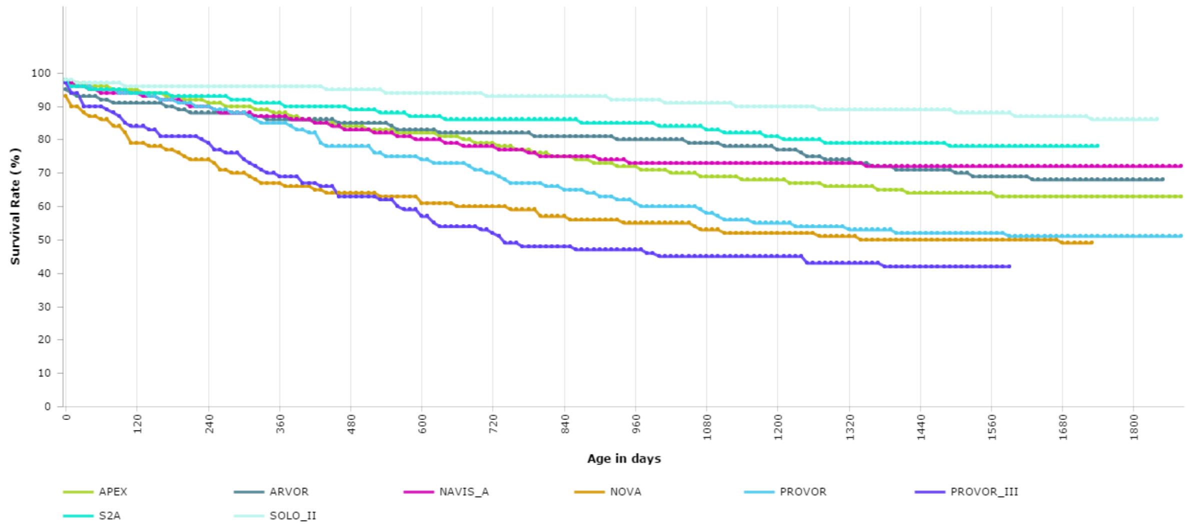
Deployments 2012-2016



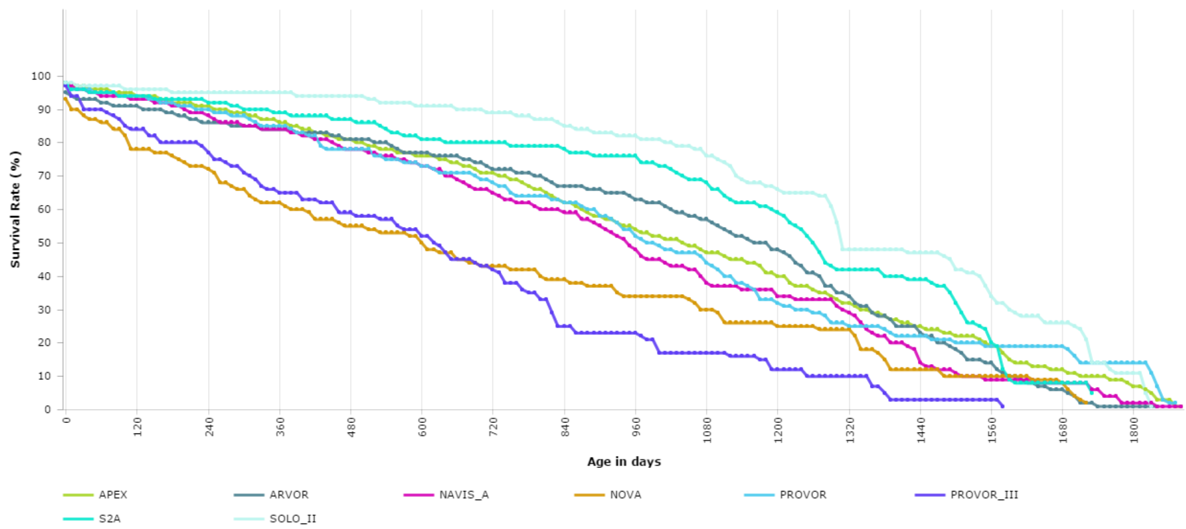
Deployments 2012-2016 Survival Rate, by generation



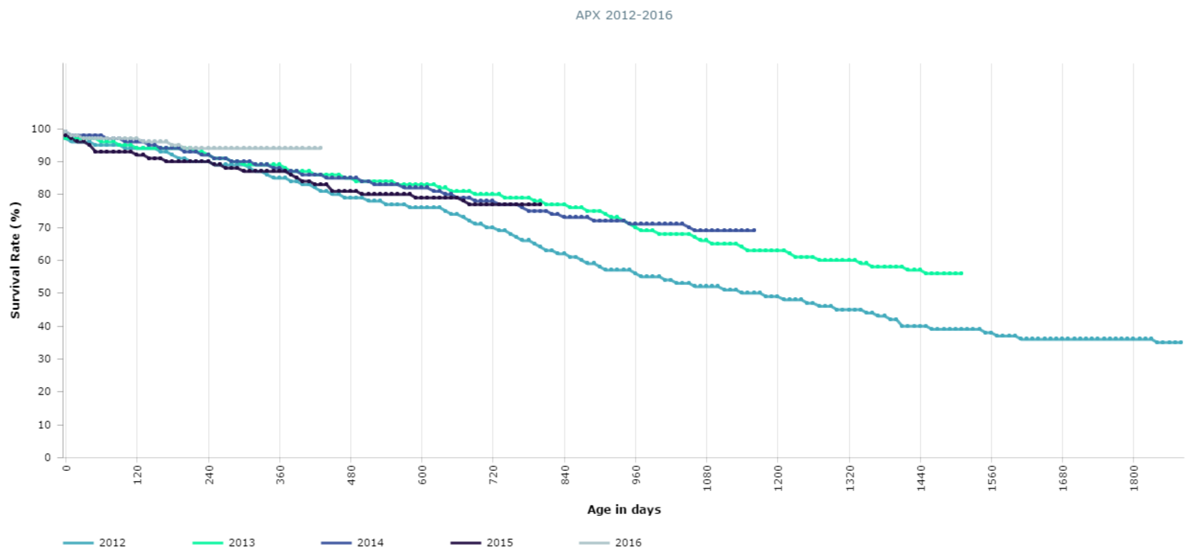
Deployments 2012-2016 Survival Rate, by deployment basin



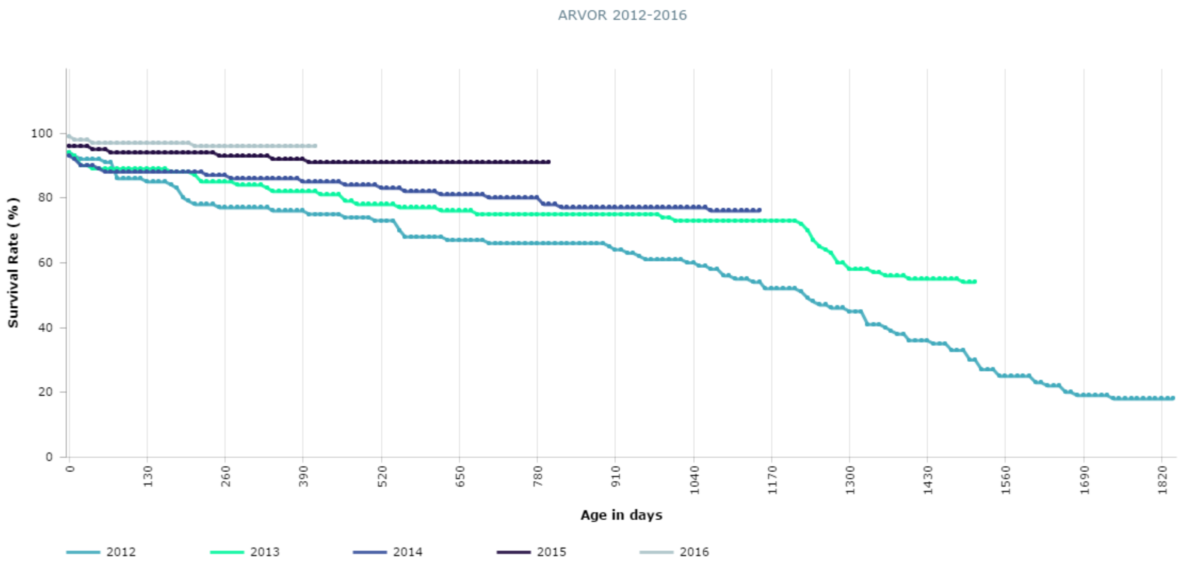
Deployments 2012-2016 Survival Rate, by float model (>100 deployments)



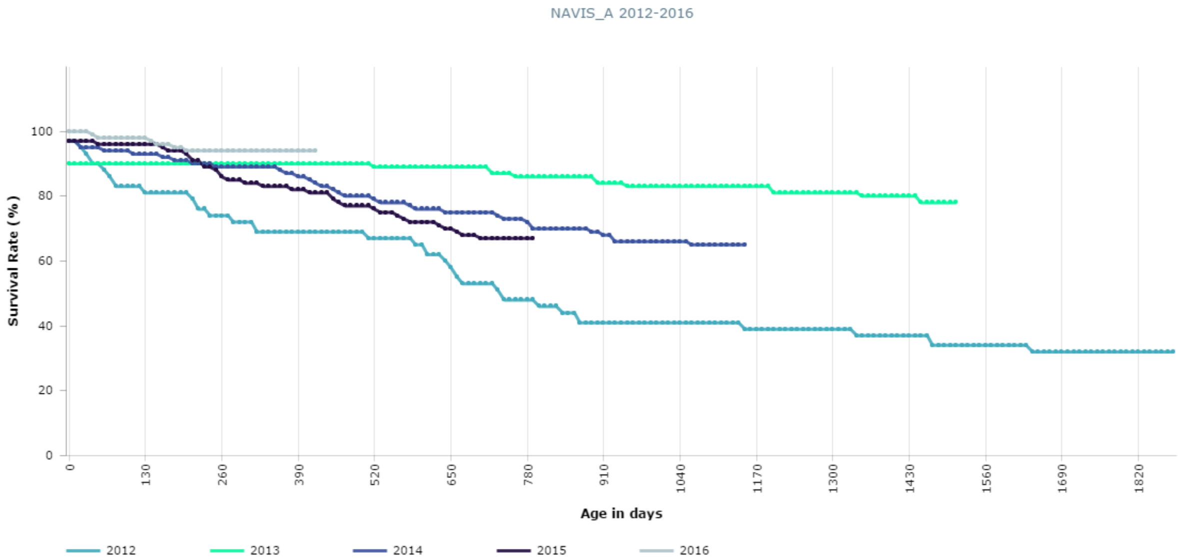
Deployments 2012-2016 Survival Rate (2), by float model (>100 deployments)



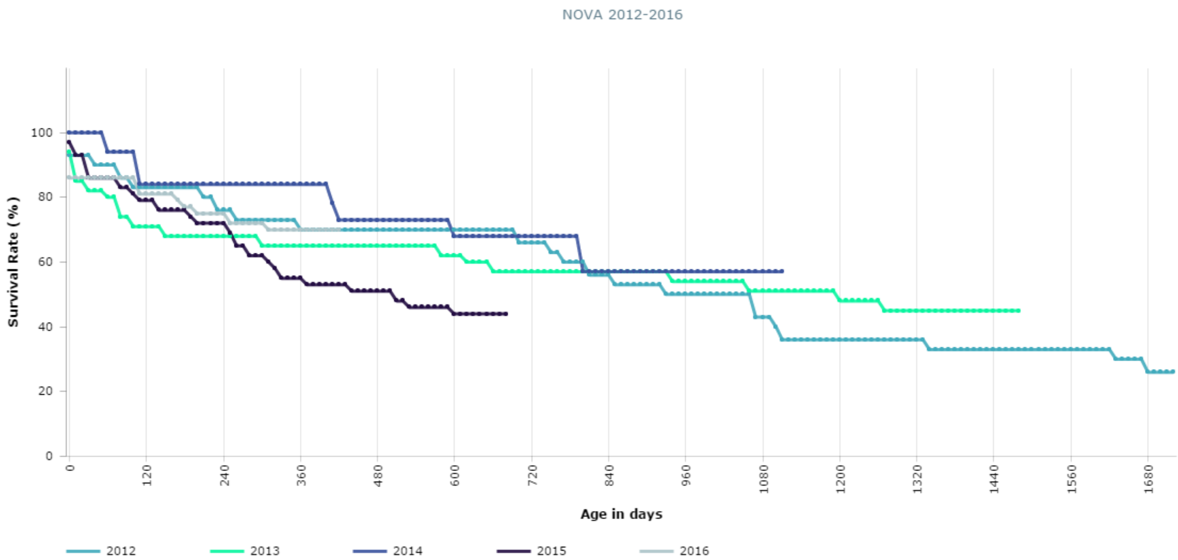
Deployments 2012-2016 Survival Rate, APEX



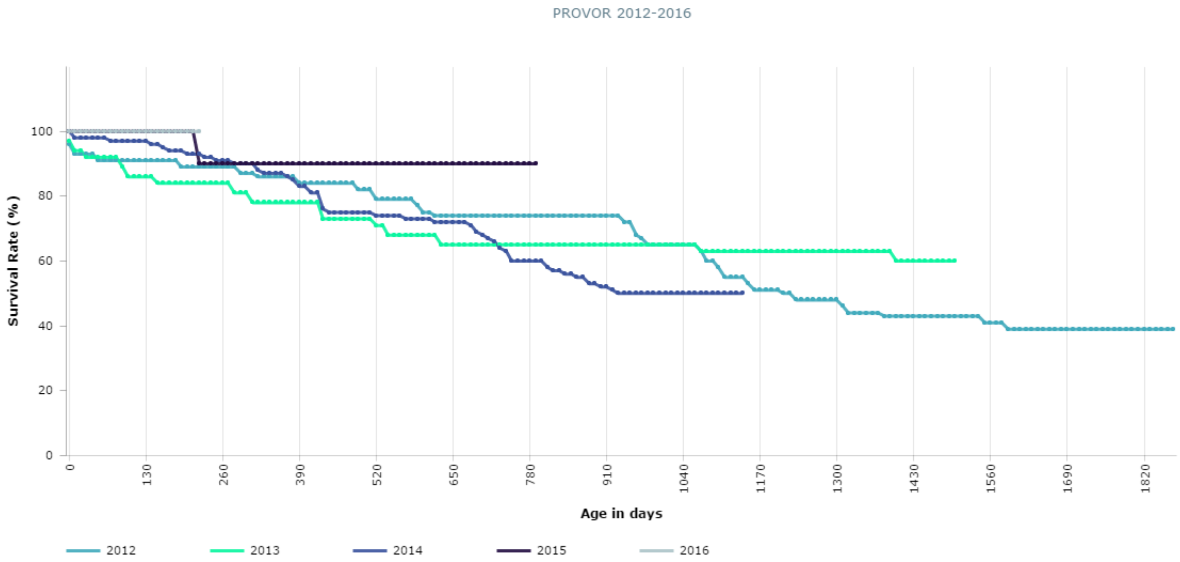
Deployments 2012-2016 Survival Rate, ARVOR



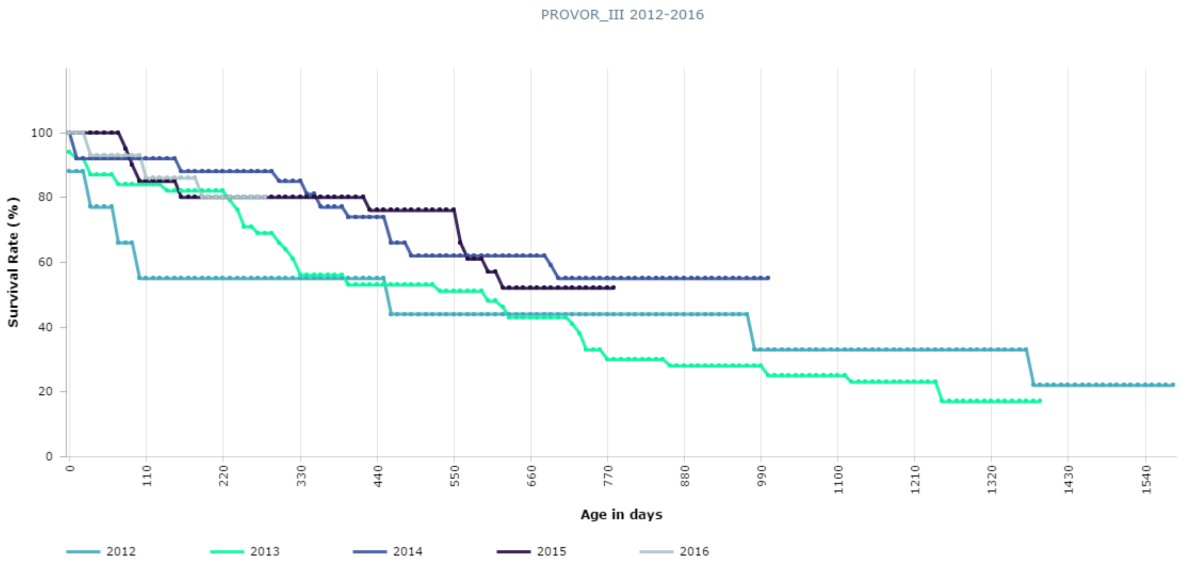
<u>Deployments 2012-2016 Survival Rate, NAVIS_A</u>



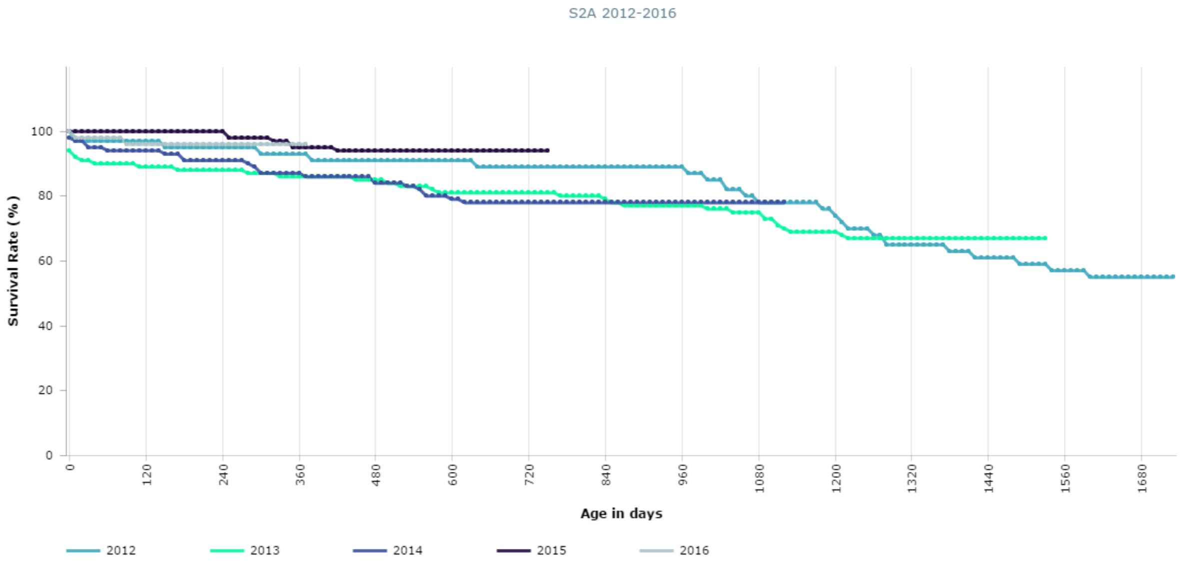
<u>Deployments 2012-2016 Survival Rate, NOVA</u>



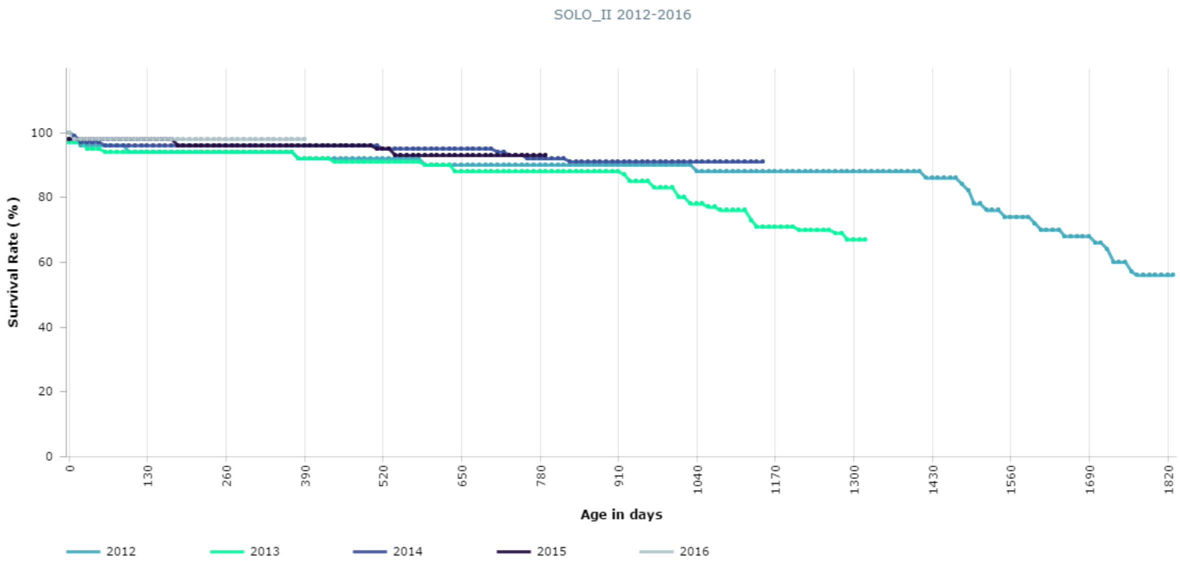
Deployments 2012-2016 Survival Rate, PROVOR



Deployments 2012-2016 Survival Rate, PROVOR_III



Deployments 2012-2016 Survival Rate, S2A

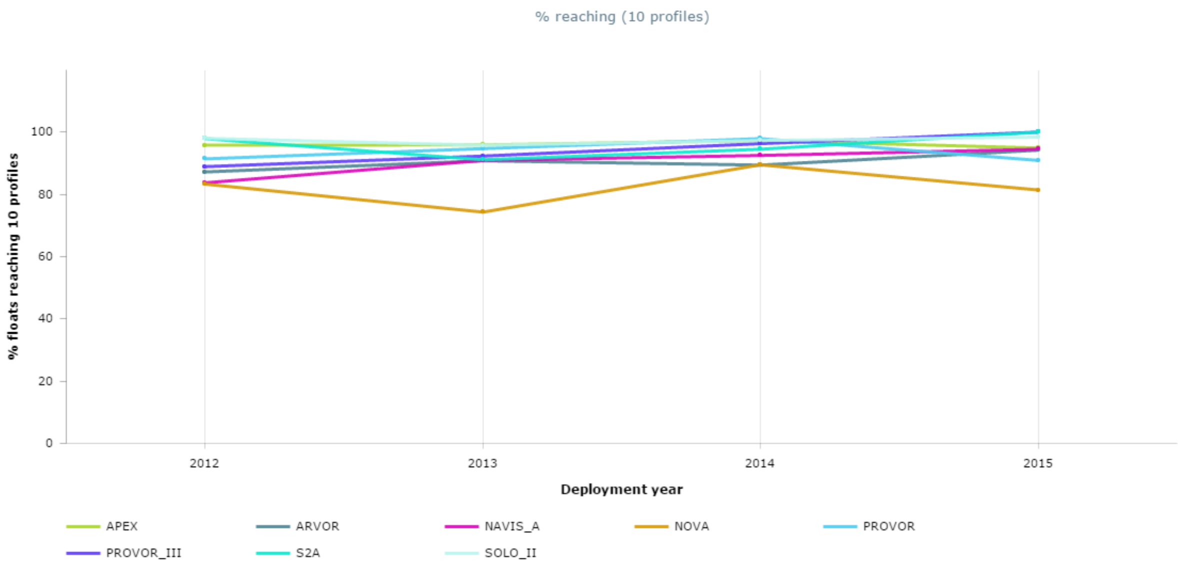


Deployments 2012-2016 Survival Rate, SOLO_II

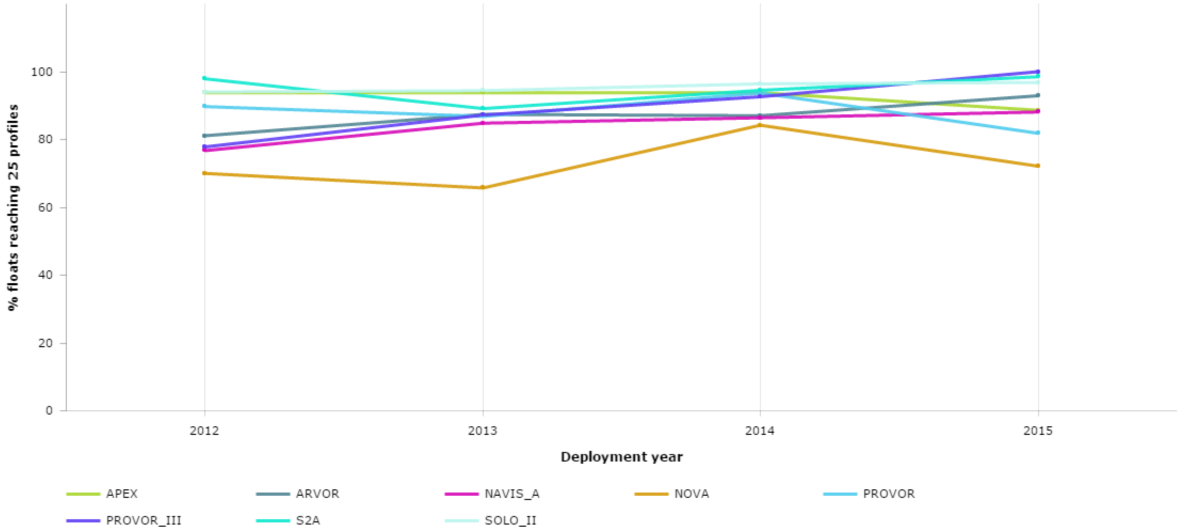
	10 profiles	25	50	75	100	125	150
ALL	95%	90	88	82	76	60	52
APEX	95	89	90	85	76	58	51
ARVOR	94	93	85	77	77	58	43
NAVIS_A	95	88	79	72	74	54	51
NOVA	81	72	84	74	57	40	37
PROVOR	91	82	87	83	66	50	47
PROVOR_III	100	100	93	82	67	56	56
S2A	100	98	85	81	81	85	68
SOLO_II	98	97	96	96	90	88	88
APEX (UW)	99	99	93	93	84	87	75
APEX (CSIRO)	93	93	95	95	88	87	83
ARVOR (IF)	97	97	93	90	76	57	56
NAVIS_A (PMEL)	96	90	83	77	81	43	40

Float sample: floats deployed in 2012-2016

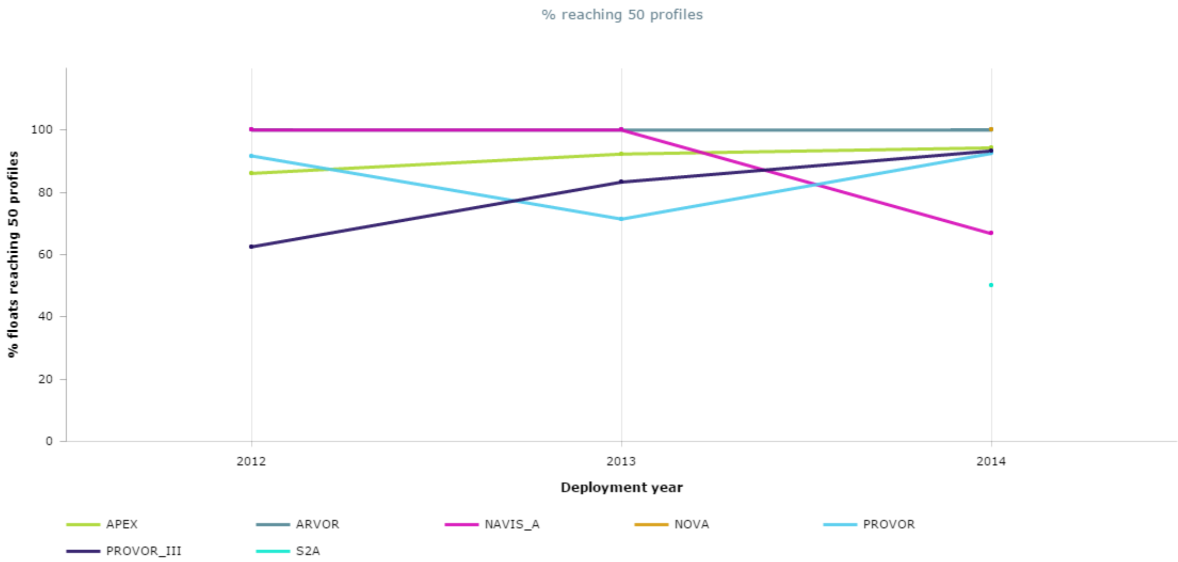
Performance on target: % of distributing N profiles, most recent value.



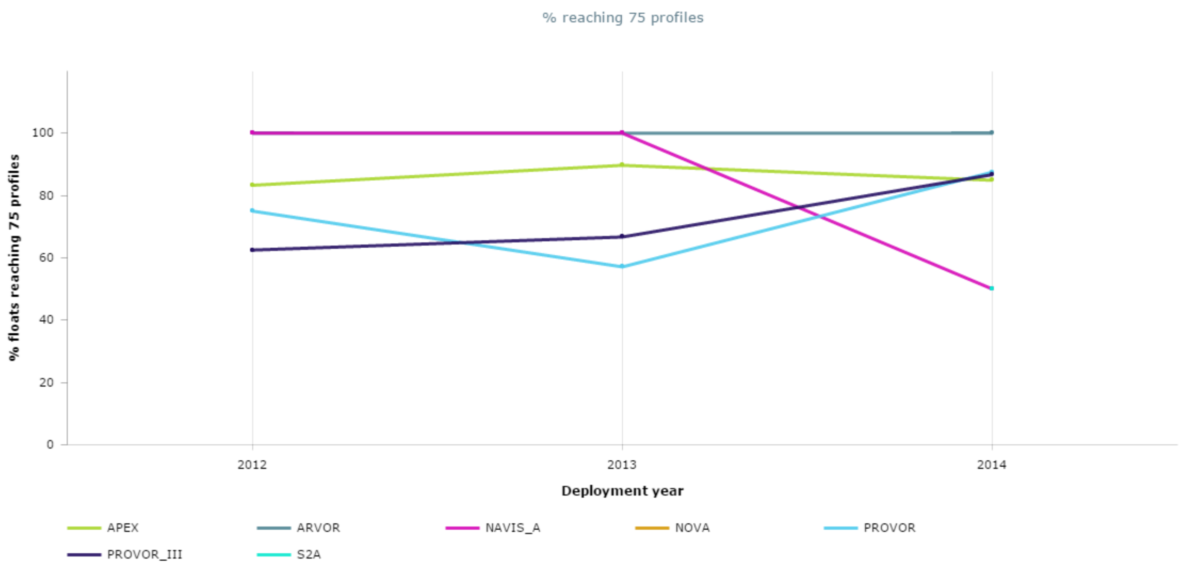
Performance on target: % of distributing 10 profiles



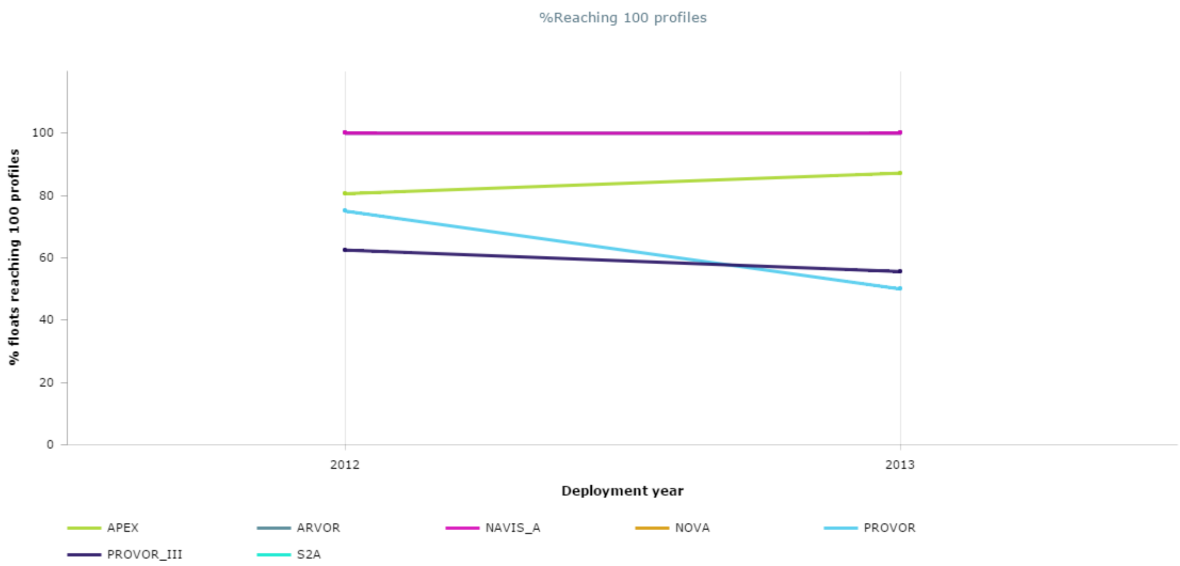
Performance on target: % of distributing 25 profiles



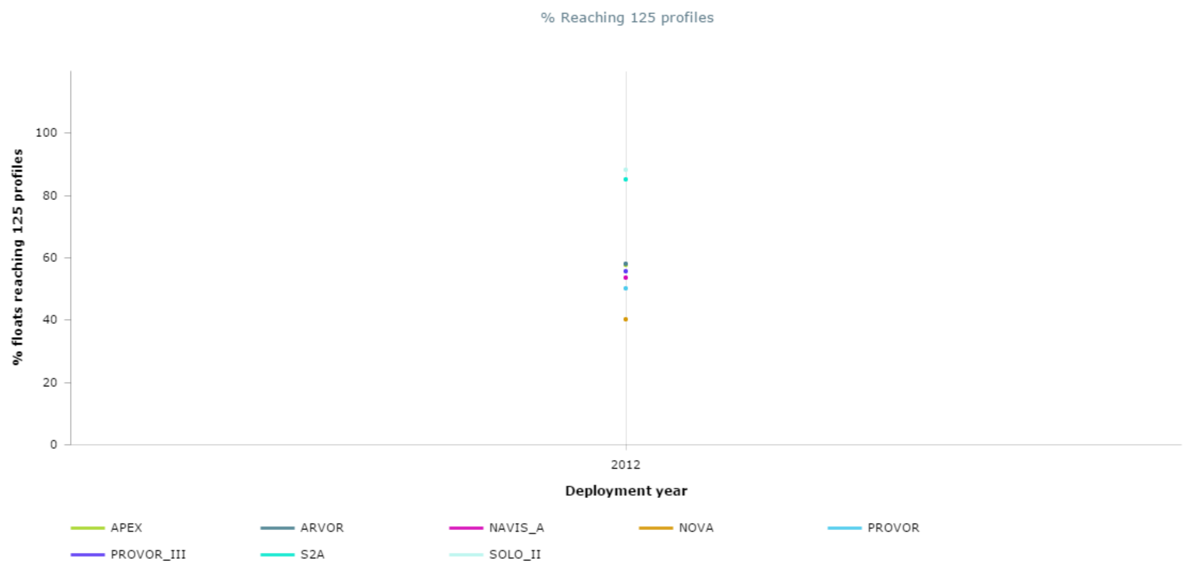
Performance on target: % of distributing 50 profiles



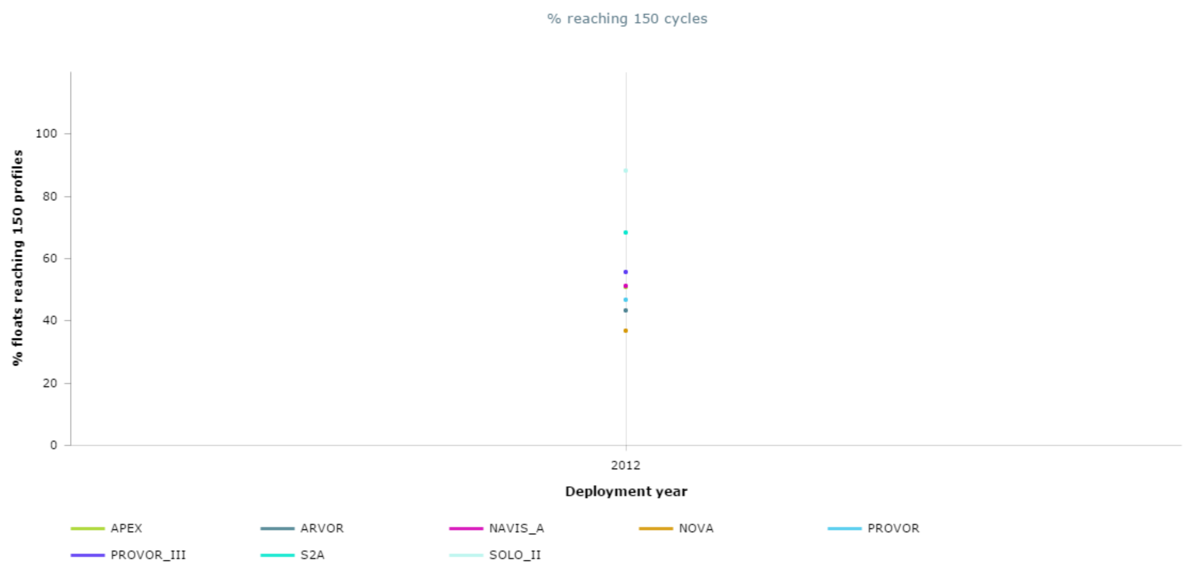
Performance on target: % of distributing 75 profiles



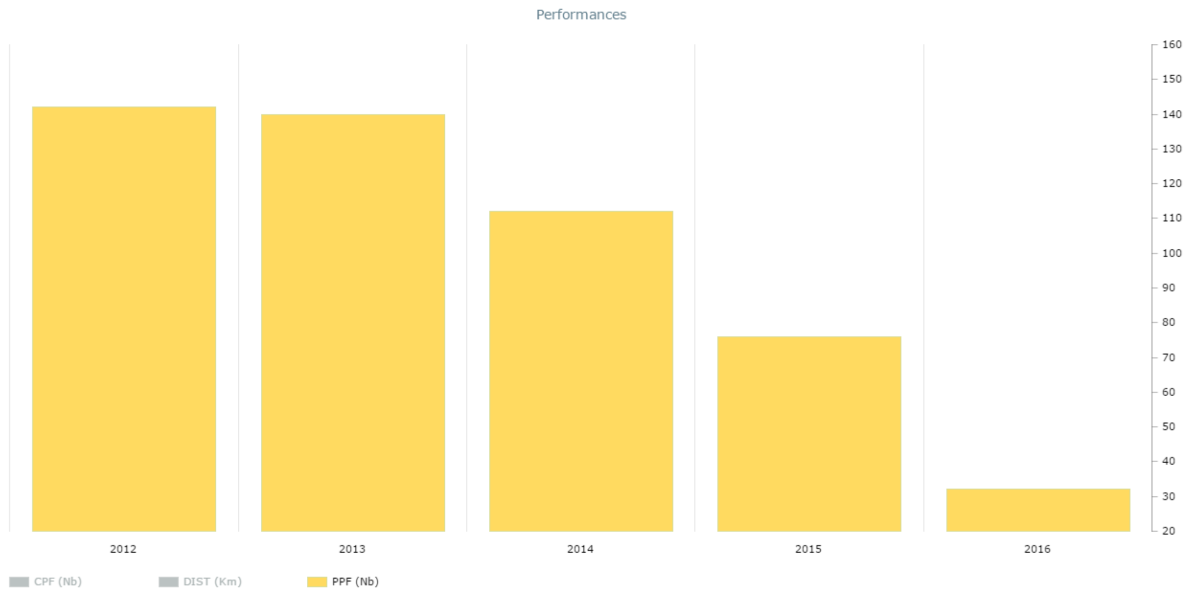
Performance on target: % of distributing 100 profiles



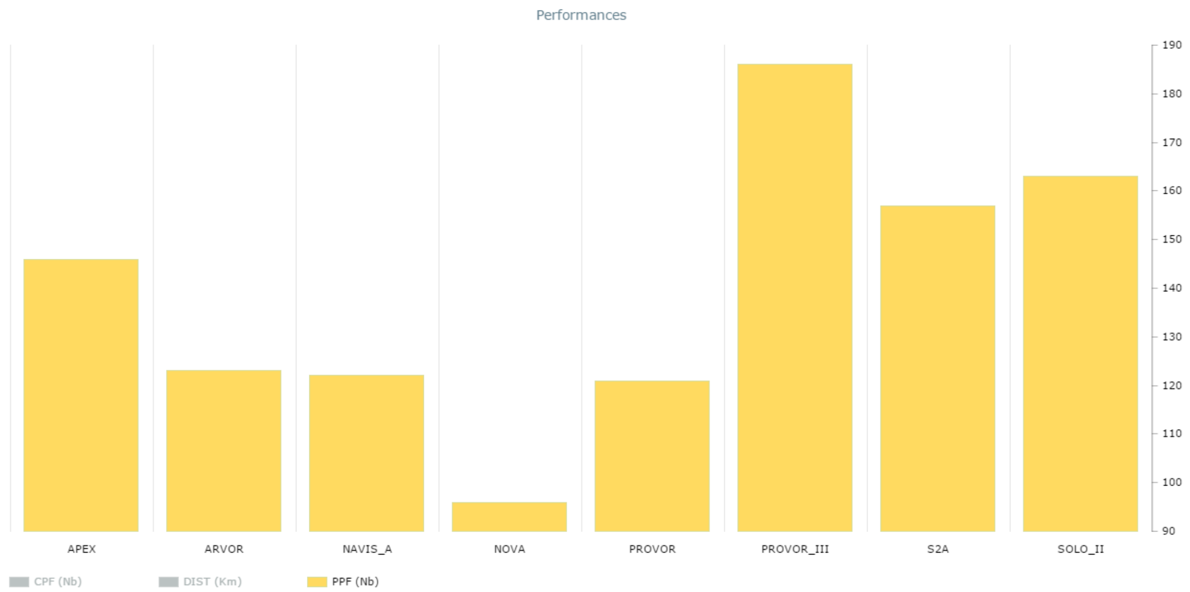
Performance on target: % of distributing 125 profiles



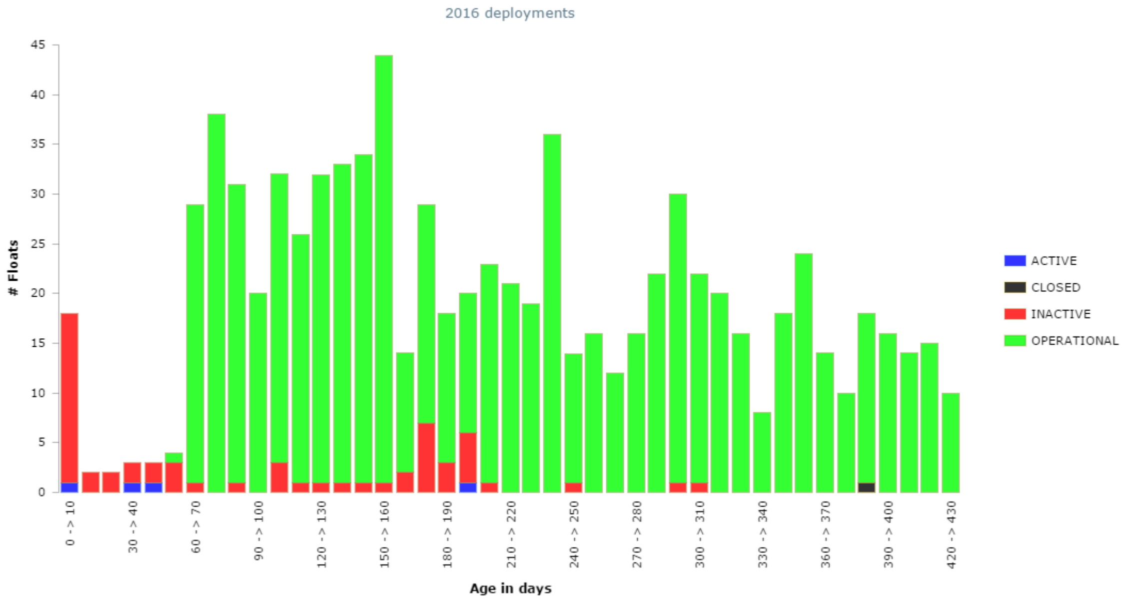
Performance on target: % of distributing 150 profiles



Average Profiles per float distributed, by generation

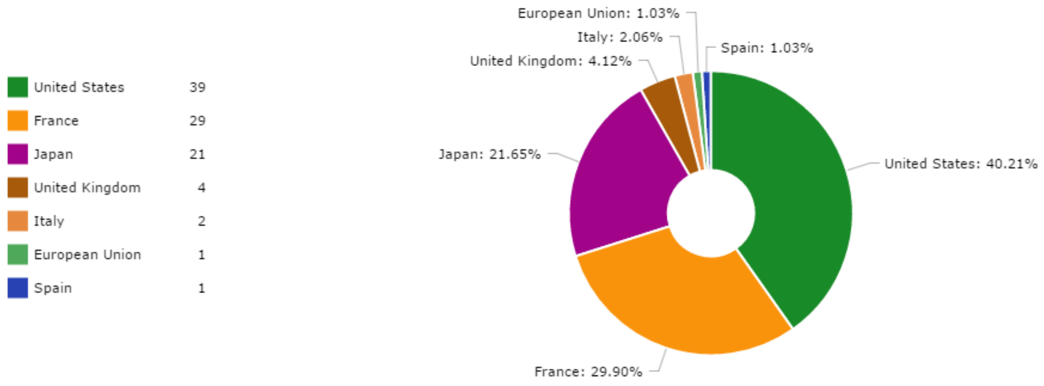


Average Profiles per float distributed, by model, for 2012-2013

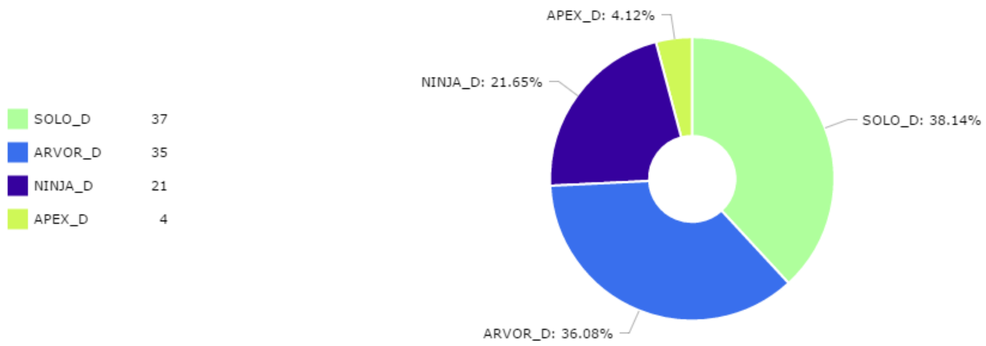


Age distribution of 2016 deployments

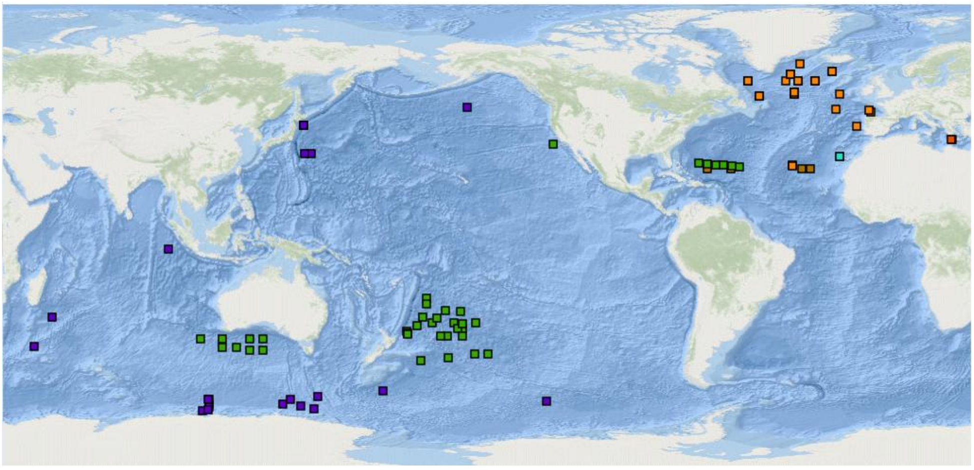
Deep Argo



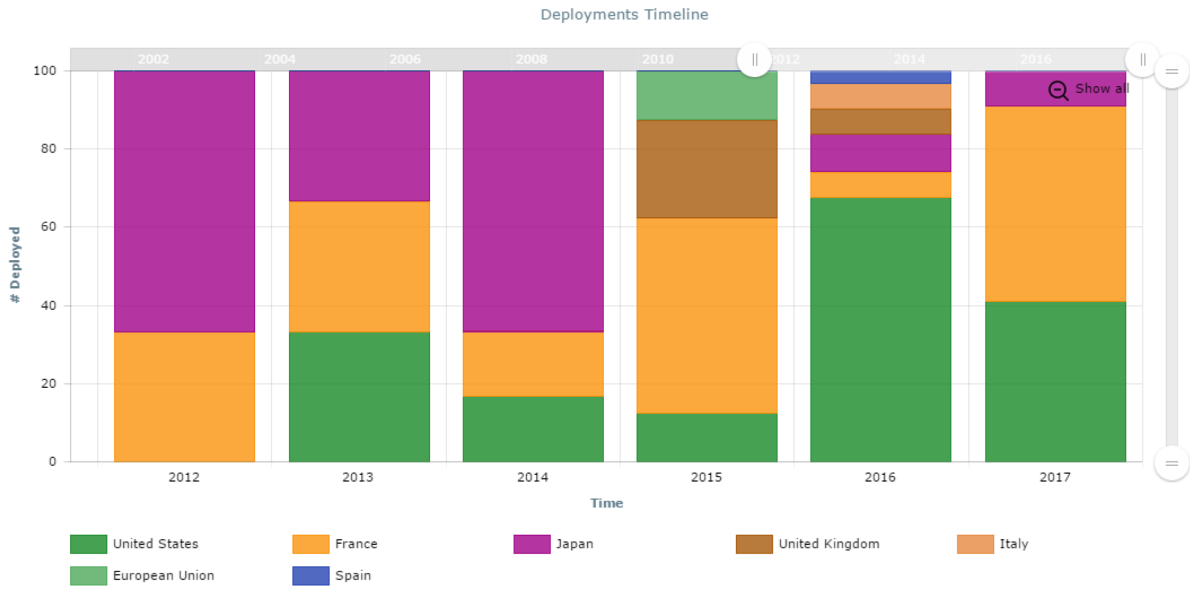
Deep Argo deploying countries



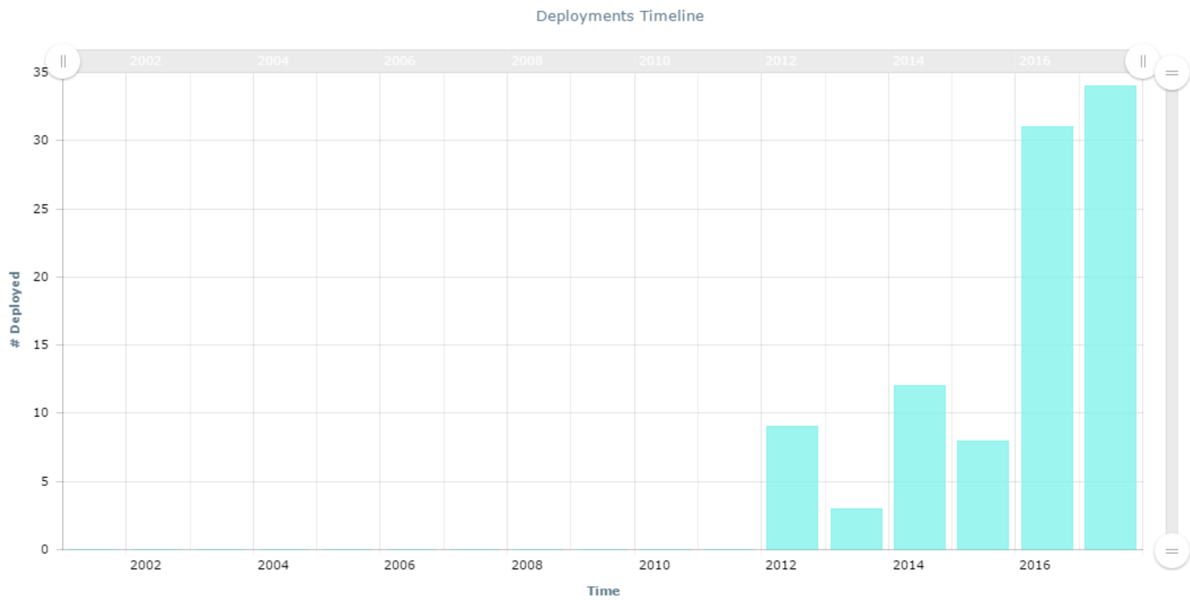
Deep Argo float models



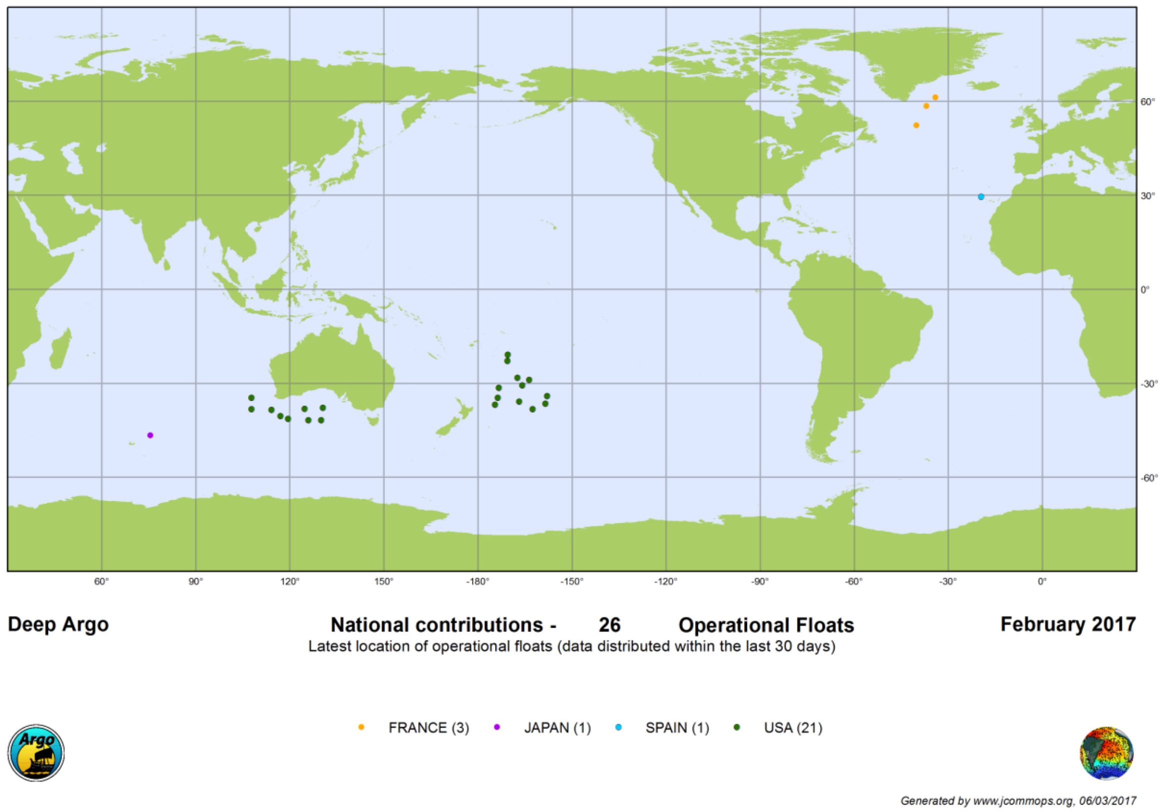
Deep Argo deployment locations, by country



Deep Argo deployment by country (%)

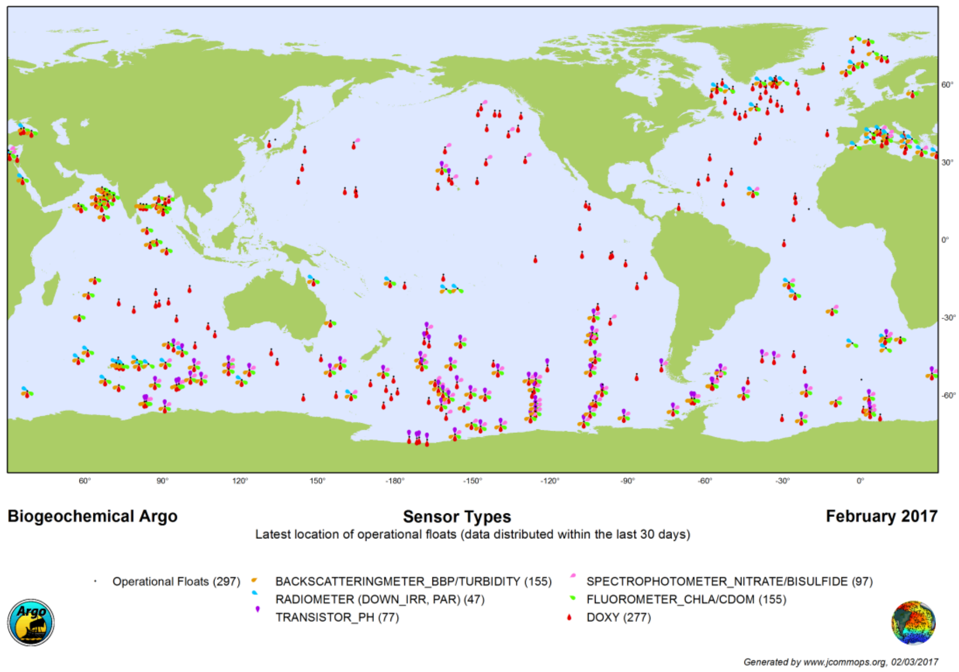


Deep Argo deployment by year (Nb)

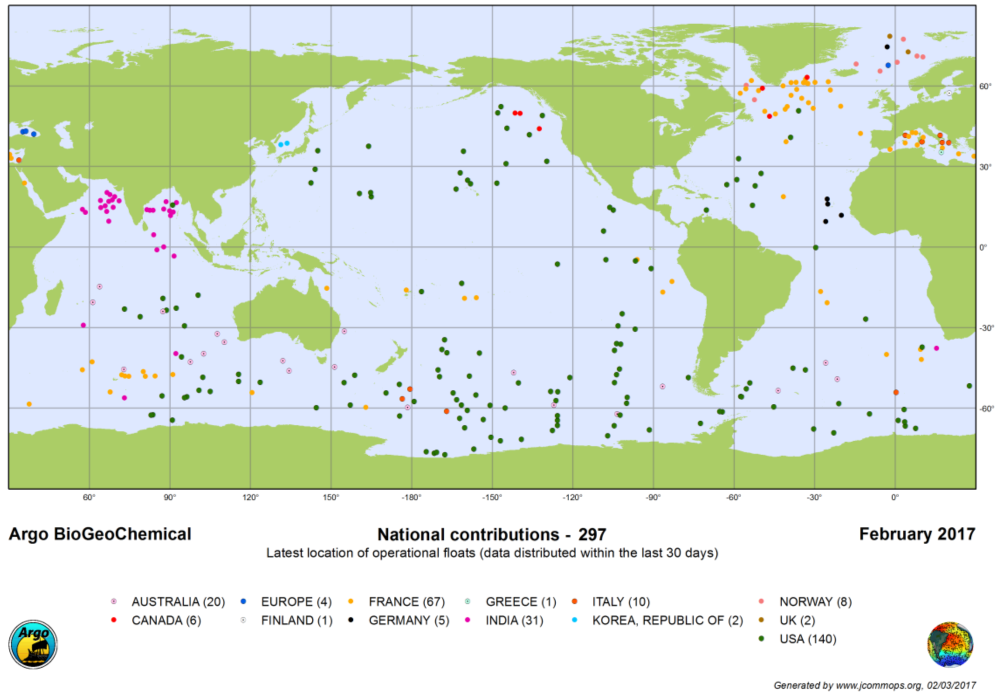


Deep Argo operational floats

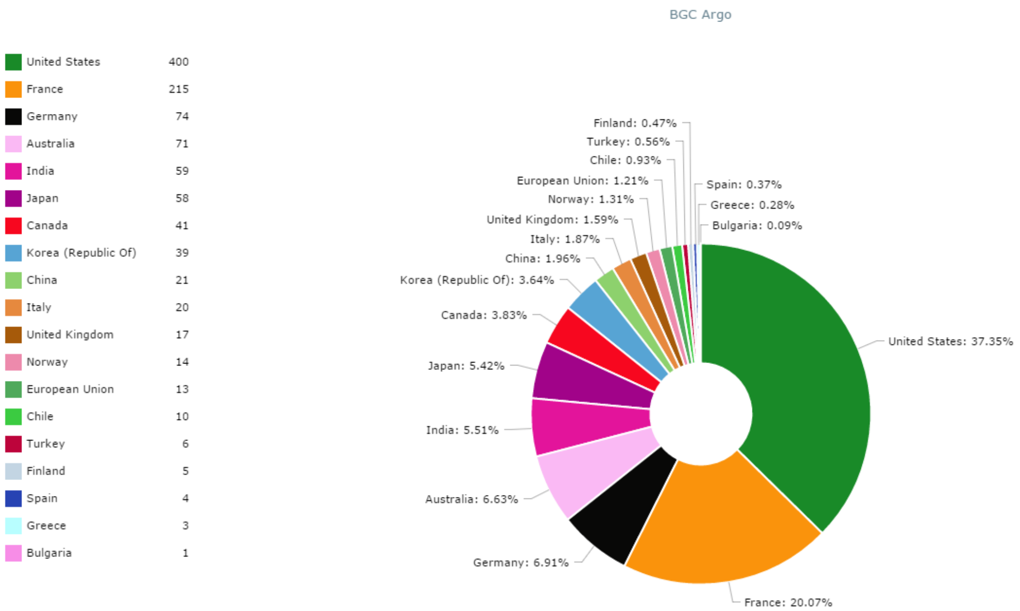
BGC Argo



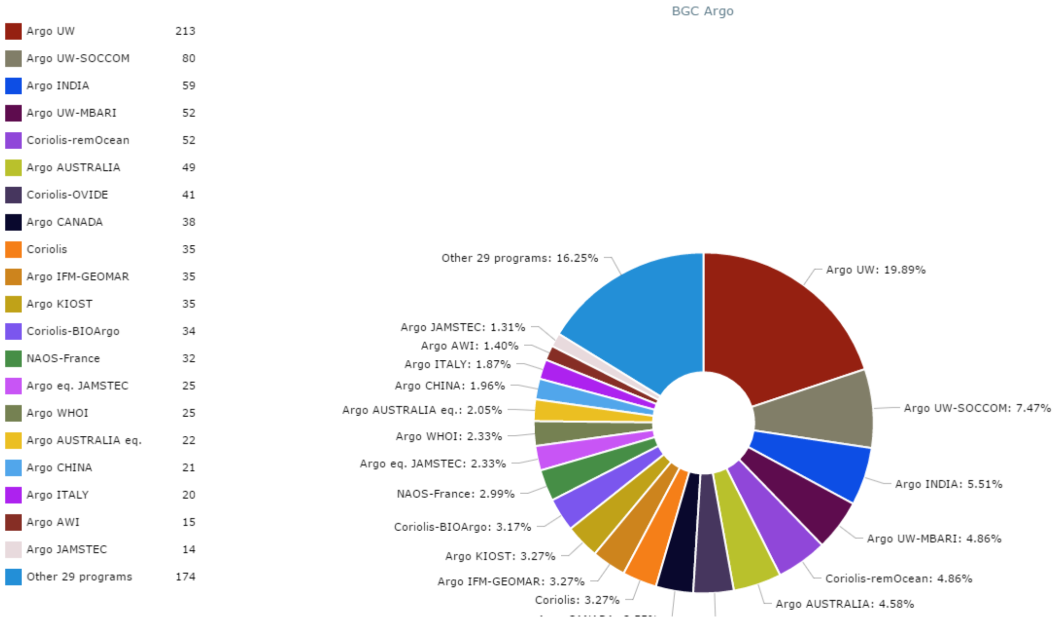
BGC Sensors, operational floats



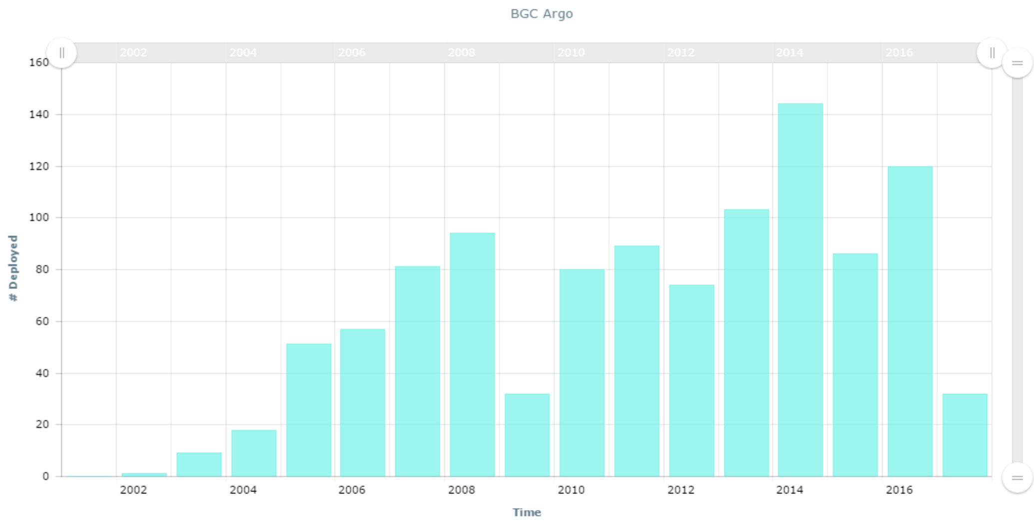
BGC National contributions, operational floats



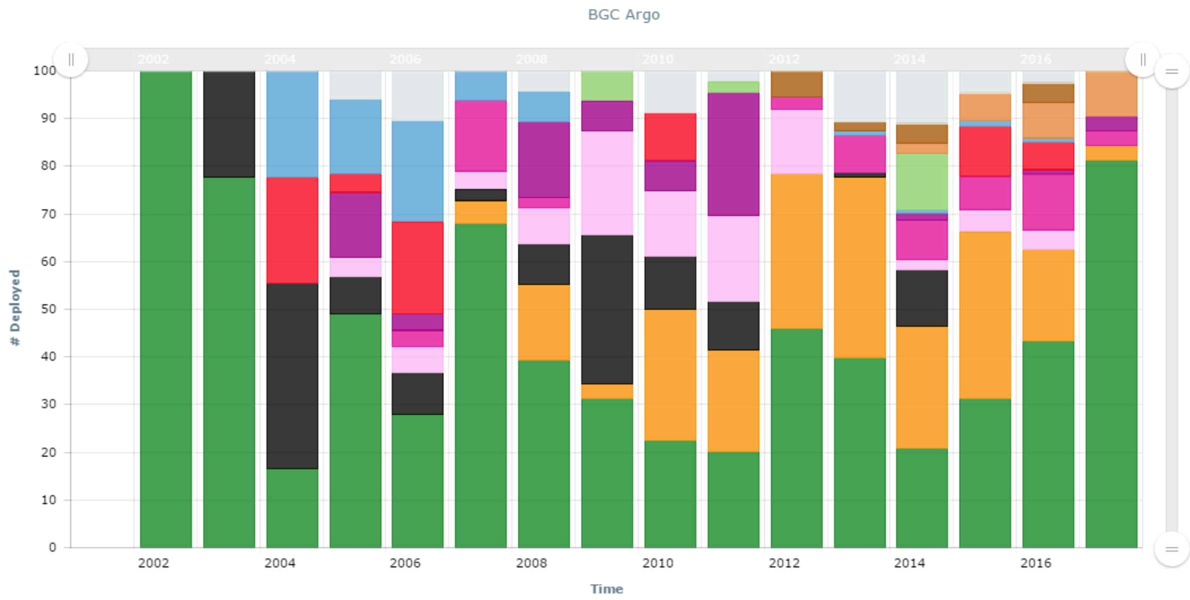
BGC Argo operational floats by national programme



BGC Argo operational floats by programme



BGC float deployments



BGC float deployments, % by country

Cruise Plans

CRUISE_REF	DEPARTURE_DATE	ARRIVAL_DATE	SHIP_REF	SHIP_NAME	LINE	LINE_FAMILY
35AY20170514	2017-05-14T00:00:00	2017-05-24T00:00:00	35AY	ALIS		
35A820170320	2017-03-20T00:00:00	2017-04-05T00:00:00	35A8	ANTEA		
35A820170512	2017-05-12T00:00:00	2017-05-18T00:00:00	35A8	ANTEA		
35A820170619	2017-06-19T00:00:00	2017-07-13T00:00:00	35A8	ANTEA		
35A820170716	2017-07-16T00:00:00	2017-07-25T00:00:00	35A8	ANTEA		
35A820170916	2017-09-16T00:00:00	2017-09-27T00:00:00	35A8	ANTEA		
35A320170314	2017-03-14T00:00:00	2017-04-13T00:00:00	35A3	ATALANTE		
35A320170628	2017-06-28T00:00:00	2017-07-05T00:00:00	35A3	ATALANTE		
35A320170707	2017-07-07T00:00:00	2017-08-11T00:00:00	35A3	ATALANTE		
33H420170325	2017-03-25T00:00:00	2017-04-01T00:00:00	33H4	ATLANTIC EXPLORER		
33AT20170101	2017-01-01T00:00:00	2017-01-10T00:00:00	33AT	ATLANTIS		
33AT20170115	2017-01-15T00:00:00	2017-02-21T00:00:00	33AT	ATLANTIS		
33AT20170312	2017-03-12T00:00:00	2017-03-22T00:00:00	33AT	ATLANTIS		
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74EQ20170403	2017-04-03T00:00:00	2017-04-10T00:00:00	74EQ	DISCOVERY		
74EQ20170523	2017-05-23T00:00:00	2017-05-28T00:00:00	74EQ	DISCOVERY		
74EQ20170606	2017-06-06T00:00:00	2017-07-02T00:00:00	74EQ	DISCOVERY		
74EQ20170705	2017-07-05T00:00:00	2017-08-10T00:00:00	74EQ	DISCOVERY		
74EQ20170921	2017-09-21T00:00:00	2017-10-31T00:00:00	74EQ	DISCOVERY		
32EV20170121	2017-01-21T00:00:00	2017-02-08T00:00:00	32EV	ENDEAVOR		

32EV20170210	2017-02-10T00:00:00	2017-02-13T00:00:00	32EV	ENDEAVOR		
32EV20170221	2017-02-21T00:00:00	2017-02-24T00:00:00	32EV	ENDEAVOR		
32EV20170425	2017-04-25T00:00:00	2017-04-29T00:00:00	32EV	ENDEAVOR		
32EV20170501	2017-05-01T00:00:00	2017-05-05T00:00:00	32EV	ENDEAVOR		
32EV20170527	2017-05-27T00:00:00	2017-05-30T00:00:00	32EV	ENDEAVOR		
32EV20170905	2017-09-05T00:00:00	2017-09-07T00:00:00	32EV	ENDEAVOR		
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TMP302592541	2017-04-15T00:00:00	2017-05-15T00:00:00		EUROPA		
096U20171114	2017-11-14T00:00:00	2017-11-26T00:00:00	096U	INVESTIGATOR		
74JC20170317	2017-03-17T00:00:00	2017-05-08T00:00:00	74JC	JAMES CLARK ROSS		
74JC20170512	2017-05-12T00:00:00	2017-05-22T00:00:00	74JC	JAMES CLARK ROSS		
74JC20170606	2017-06-06T00:00:00	2017-06-24T00:00:00	74JC	JAMES CLARK ROSS		
74JC20170819	2017-08-19T00:00:00	2017-08-22T00:00:00	74JC	JAMES CLARK ROSS		
740H20170228	2017-02-28T00:00:00	2017-04-08T00:00:00	740H	JAMES COOK		
740H20170417	2017-04-17T00:00:00	2017-05-03T00:00:00	740H	JAMES COOK		
740H20170625	2017-06-25T00:00:00	2017-08-12T00:00:00	740H	JAMES COOK		
740H20171220	2017-12-20T00:00:00	2018-02-01T00:00:00	740H	JAMES COOK		
49UF20170401	2017-04-01T00:00:00	2017-04-30T00:00:00	49UF	KEIFU MARU		
49UF20170515	2017-05-15T00:00:00	2017-06-14T00:00:00	49UF	KEIFU MARU		
49UF20170615	2017-06-15T00:00:00	2017-07-14T00:00:00	49UF	KEIFU MARU		
49UF20170715	2017-07-15T00:00:00	2017-09-14T00:00:00	49UF	KEIFU MARU		
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33KB20170903	2017-09-03T00:00:00	2017-09-26T00:00:00	33KB	KILO MOANA		
33LG20170413	2017-04-13T00:00:00	2017-05-28T00:00:00	33LG	LAURENCE M. GOULD		
SIVY20170407	2017-04-07T00:00:00	2017-04-26T00:00:00	SIVY	MAERSK VISBY		
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06M220170528	2017-05-28T00:00:00	2017-06-22T00:00:00	06M2	MARIA S. MERIAN		
06M220170626	2017-06-26T00:00:00	2017-07-19T00:00:00	06M2	MARIA S. MERIAN		
06M220170723	2017-07-23T00:00:00	2017-08-28T00:00:00	06M2	MARIA S. MERIAN		
06M220170901	2017-09-01T00:00:00	2017-10-04T00:00:00	06M2	MARIA S. MERIAN		
06M220170101	2017-01-01T00:00:00	2017-02-01T00:00:00	06M2	MARIA S. MERIAN	A10	GO-SHIP Line
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35MV20170918	2017-09-18T00:00:00	2017-10-24T00:00:00	35MV	MARION DUFRESNE		
35MV20171025	2017-10-25T00:00:00	2017-11-05T00:00:00	35MV	MARION DUFRESNE		
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06M320170601	2017-06-01T00:00:00	2017-08-08T00:00:00	06M3	METEOR		
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49NZ20170601	2017-06-01T00:00:00	2017-06-30T00:00:00	49NZ	MIRAI		

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320620170703	2017-07-03T00:00:00	2017-08-18T00:00:00	3206	NATHANIEL B. PALMER		
320620170821	2017-08-21T00:00:00	2017-09-30T00:00:00	3206	NATHANIEL B. PALMER		
320620170701	2017-07-01T00:00:00	2017-09-30T00:00:00	3206	NATHANIEL B. PALMER	P06	GO-SHIP Line
TMP1408695010	2017-02-16T00:00:00	2017-02-20T00:00:00		NEIL ARMSTRONG		
67CE20170622	2017-06-22T00:00:00	2017-07-22T00:00:00	67CE	OCEANIA		
32OC20170624	2017-06-24T00:00:00	2017-07-05T00:00:00	32OC	OCEANUS		
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32OC20170808	2017-08-08T00:00:00	2017-08-24T00:00:00	32OC	OCEANUS		
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33RR20170415	2017-04-15T00:00:00	2017-05-14T00:00:00	33RR	ROGER REVELLE		
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91AH20171101	2017-11-01T00:00:00	2017-02-28T00:00:00	91AH	S.A. AGULHAS II		
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91AH20171215	2017-12-15T00:00:00	2018-01-15T00:00:00	91AH	S.A. AGULHAS II		
33BI20170303	2017-03-03T00:00:00	2017-04-04T00:00:00	33BI	SIKULIAQ		
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33BI20170604	2017-06-04T00:00:00	2017-06-07T00:00:00	33BI	SIKULIAQ		
33BI20170630	2017-06-30T00:00:00	2017-07-03T00:00:00	33BI	SIKULIAQ		
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325020171118	2017-11-18T00:00:00	2017-12-03T00:00:00	3250	THOMAS G. THOMPSON		
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TMP1998836659	2017-06-01T00:00:00	2017-06-30T00:00:00			AR07W	GO-SHIP Line
TMP1835908470	2017-08-01T00:00:00	2017-08-31T00:00:00			ARC02	GO-SHIP Line
TMP1033623160	2017-04-01T00:00:00	2017-04-30T00:00:00			AR28	GO-SHIP Line
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TMP1367788469	2017-04-27T00:00:00	2017-05-23T00:00:00			A02	GO-SHIP Line
TMP110614601	2017-05-01T00:00:00	2017-05-31T00:00:00			GAS06	GO-SHIP Line
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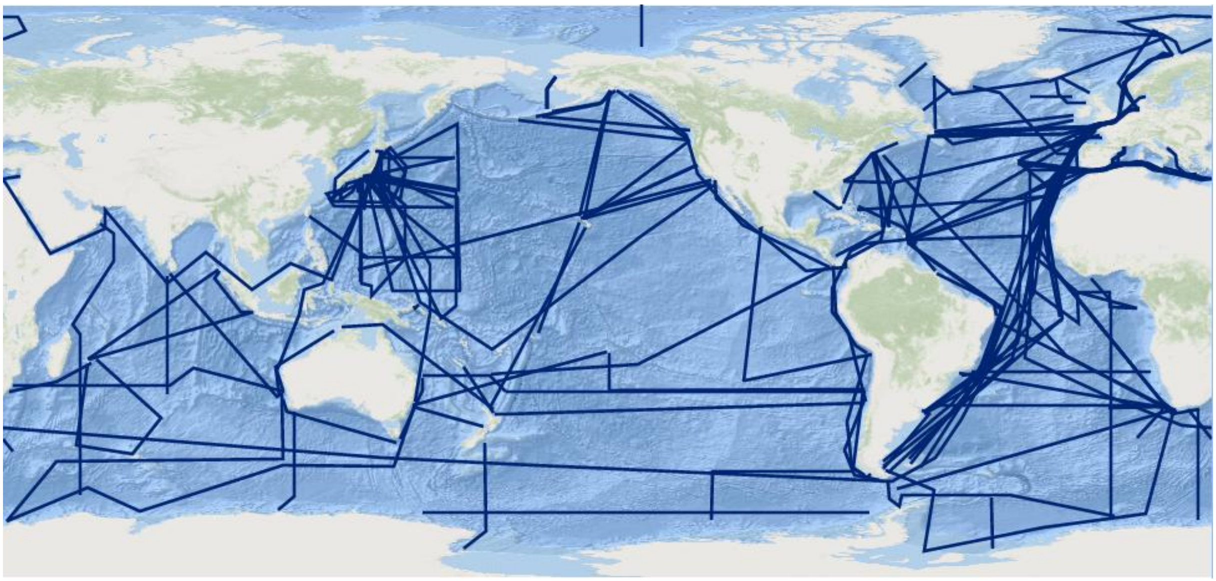
TMP1233230041	2017-11-01T00:00:00	2017-11-30T00:00:00				
TMP2072260796	2017-12-01T00:00:00	2018-03-01T00:00:00				
TMP1124258116	2017-04-09T00:00:00	2018-06-01T00:00:00				
TMP268579500	2017-07-01T00:00:00	2017-07-31T00:00:00			Davis	GO-SHIP Line

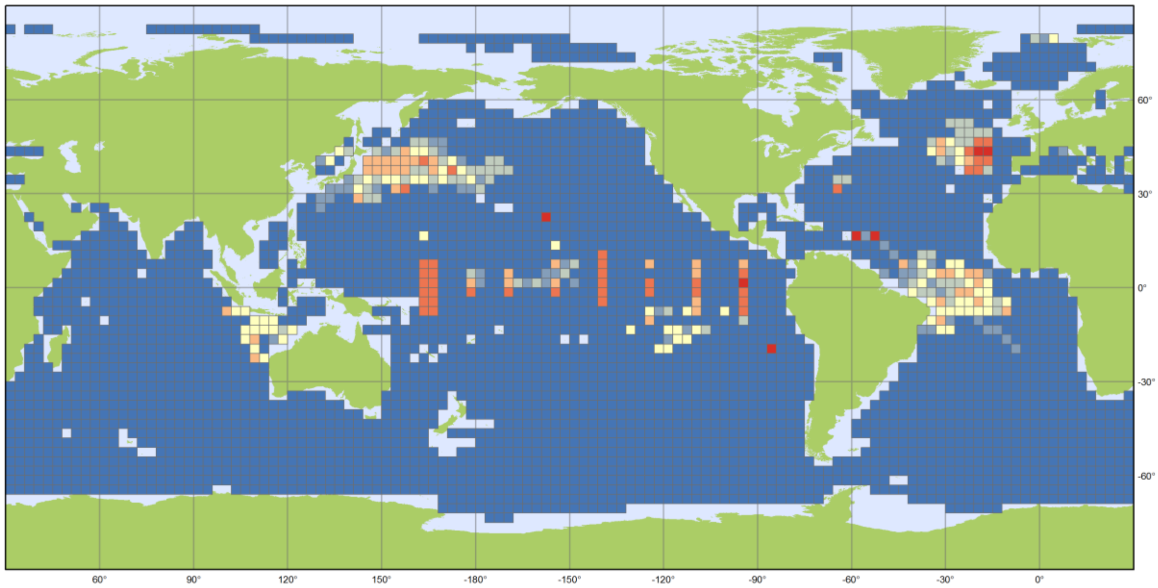
Cruises Plans for 2017 and beyond, registered @JCOMMOPS



Cruises Plans for 2017 and beyond, registered @JCOMMOPS

Note: Latest Ron Brown 2017 plans are being processed for registration, in cooperation with NOAA, to ensure security concerns are respected.

More Maps …



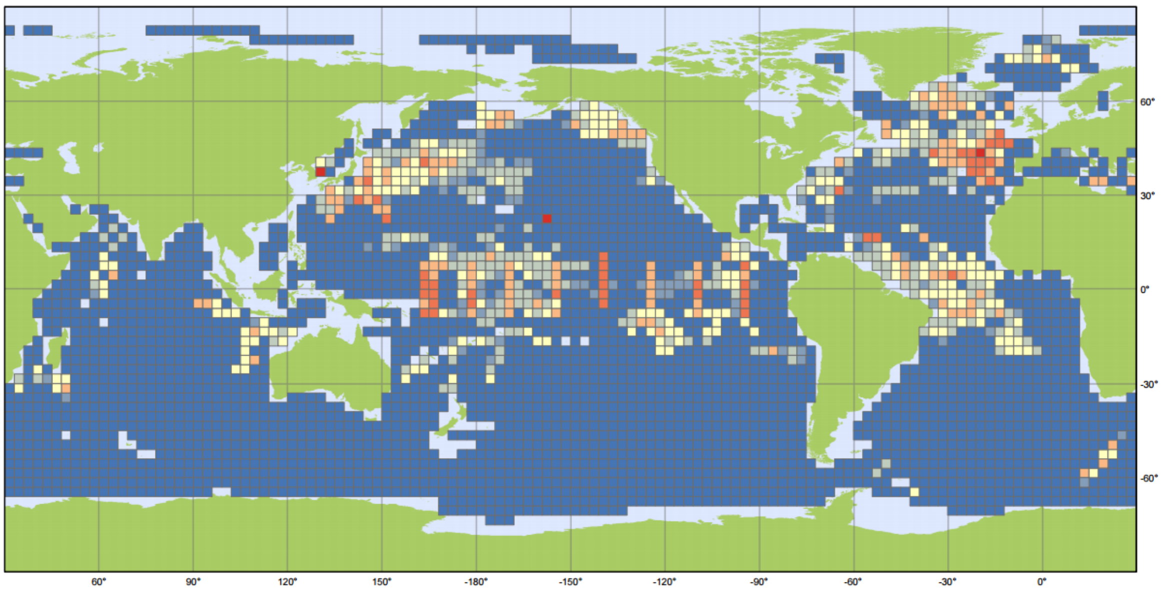
Argo **Coverage - 2000** **2000**

Average of monthly observations distributed at GDACs over calendar year

0.00 (3365) | 1.01 - 2.00 (65) | 3.01 - 6.00 (46) | > 15 (7)

0.01 - 1.00 (53) | 2.01 - 3.00 (72) | 6.01 - 15.00 (40)

Generated by www.jcommops.org, 28/07/2016



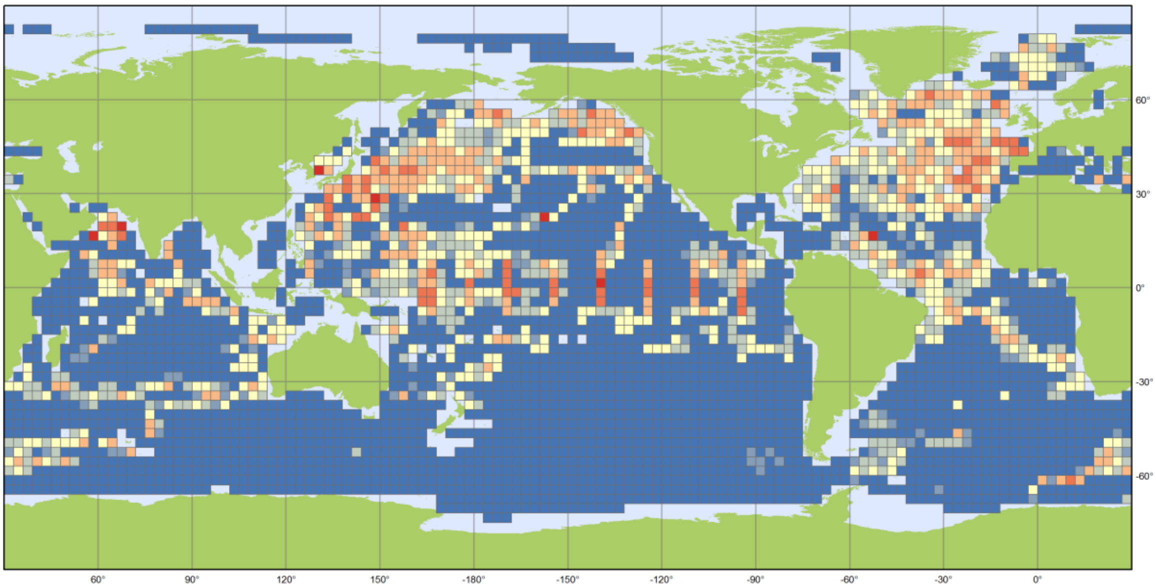
Argo **Coverage - 2001** **2001**

Average of monthly observations distributed at GDACs over calendar year

0.00 (2967) | 1.01 - 2.00 (214) | 3.01 - 6.00 (121) | > 15 (3)

0.01 - 1.00 (89) | 2.01 - 3.00 (208) | 6.01 - 15.00 (46)

Generated by www.jcommops.org, 28/07/2016

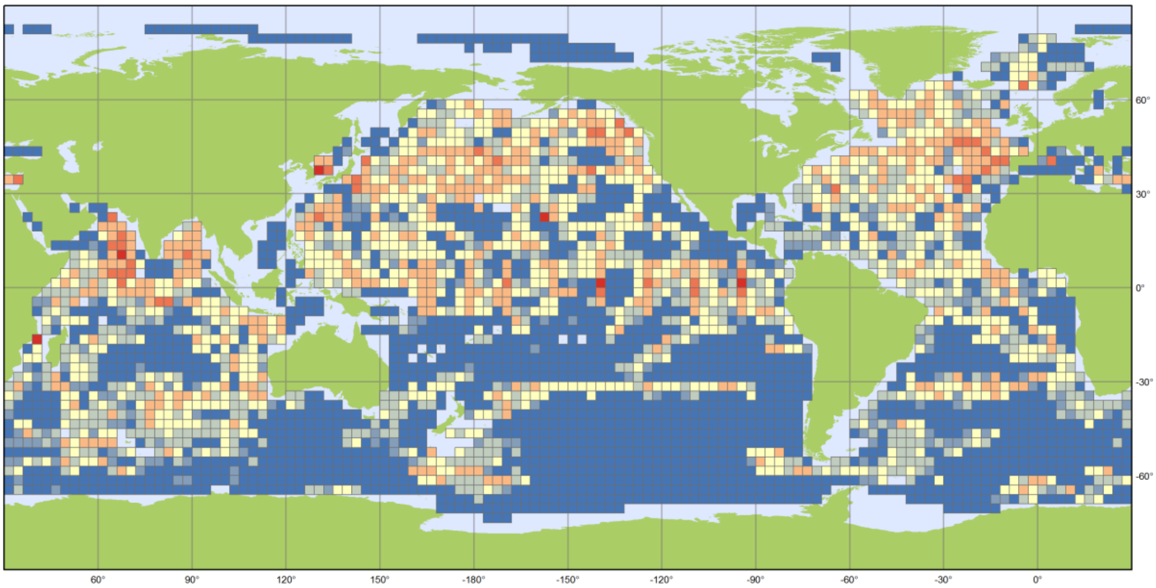


Argo **Coverage - 2002** **2002**

Average of monthly observations distributed at GDACs over calendar year

0.00 (2449) 1.01 - 2.00 (318) 3.01 - 6.00 (273) > 15 (7)
0.01 - 1.00 (134) 2.01 - 3.00 (402) 6.01 - 15.00 (65)

Generated by www.jcommops.org, 28/07/2016

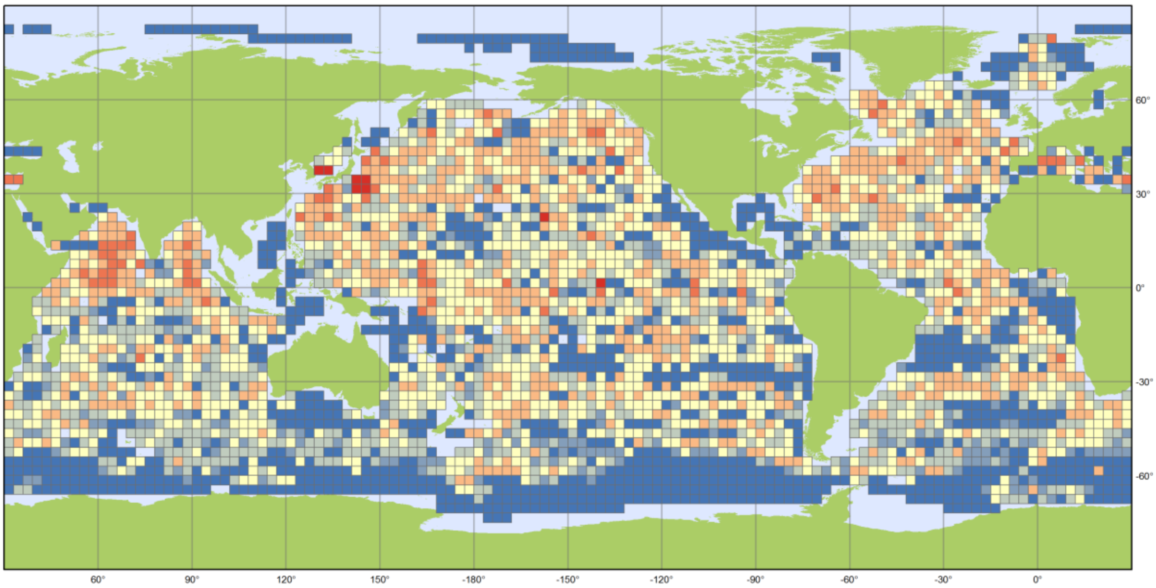


Argo **Coverage - 2003** **2003**

Average of monthly observations distributed at GDACs over calendar year

0.00 (1728) 1.01 - 2.00 (518) 3.01 - 6.00 (436) > 15 (6)
0.01 - 1.00 (209) 2.01 - 3.00 (706) 6.01 - 15.00 (45)

Generated by www.jcommops.org, 28/07/2016



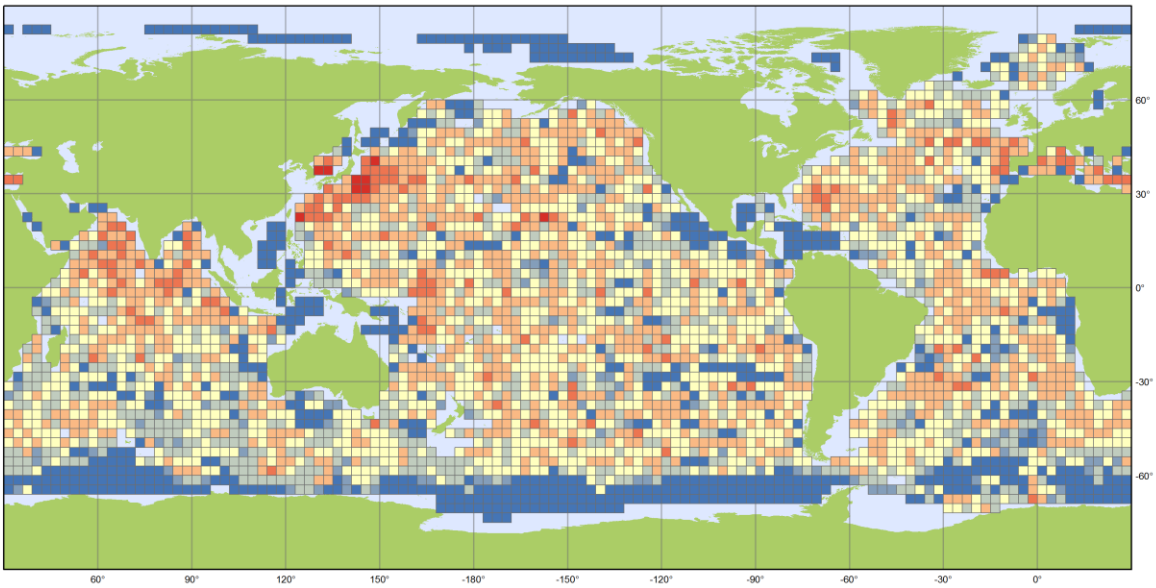
Argo **Coverage - 2004** **2004**

Average of monthly observations distributed at GDACs over calendar year

0.00 (1078) | 1.01 - 2.00 (645) | 3.01 - 6.00 (685) | > 15 (8)

0.01 - 1.00 (224) | 2.01 - 3.00 (932) | 6.01 - 15.00 (76)

Generated by www.jcommops.org, 28/07/2016



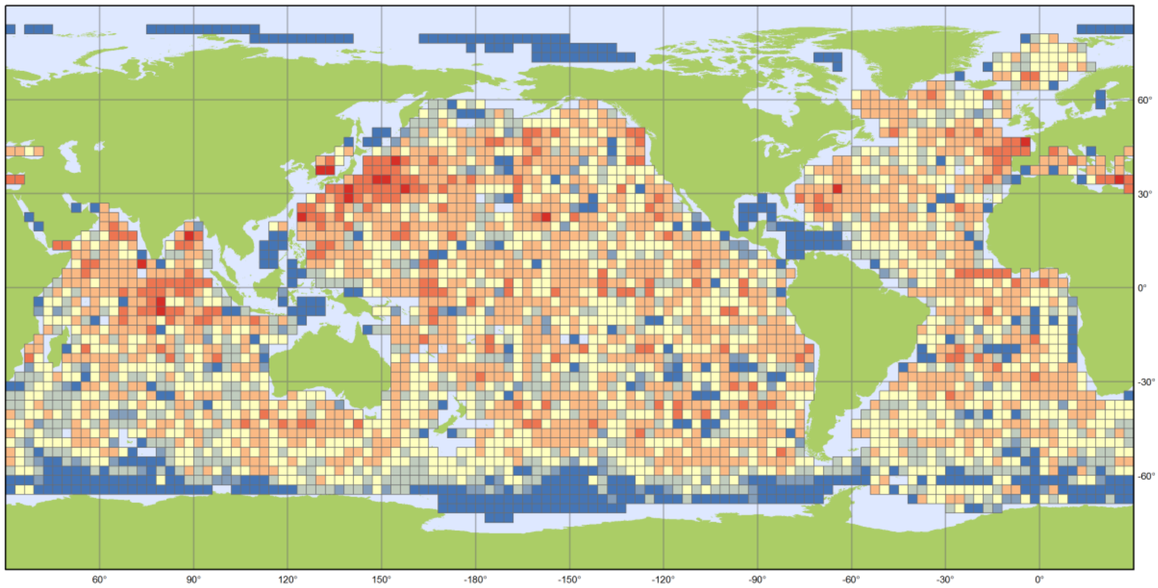
Argo **Coverage - 2005** **2005**

Average of monthly observations distributed at GDACs over calendar year

0.00 (671) | 1.01 - 2.00 (647) | 3.01 - 6.00 (975) | > 15 (9)

0.01 - 1.00 (129) | 2.01 - 3.00 (1069) | 6.01 - 15.00 (148)

Generated by www.jcommops.org, 28/07/2016

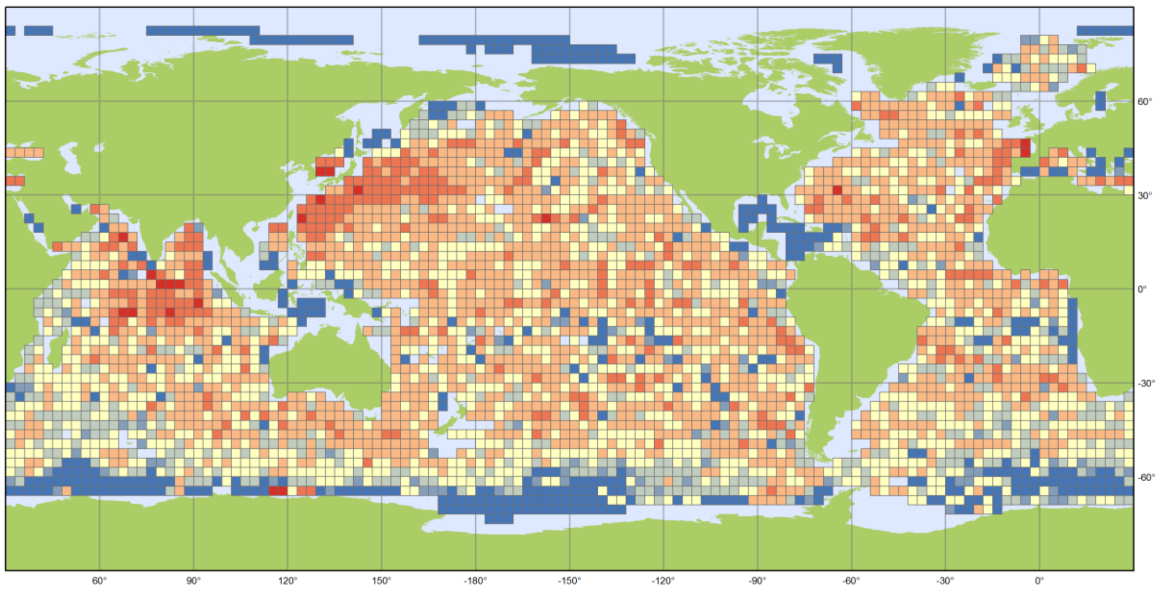


Argo **Coverage - 2006** **2006**

Average of monthly observations distributed at GDACs over calendar year

- 0.00 (486)
- 0.01 - 1.00 (114)
- 1.01 - 2.00 (509)
- 2.01 - 3.00 (1058)
- 3.01 - 6.00 (1238)
- 6.01 - 15.00 (226)
- > 15 (17)

Generated by www.jcommops.org, 28/07/2016

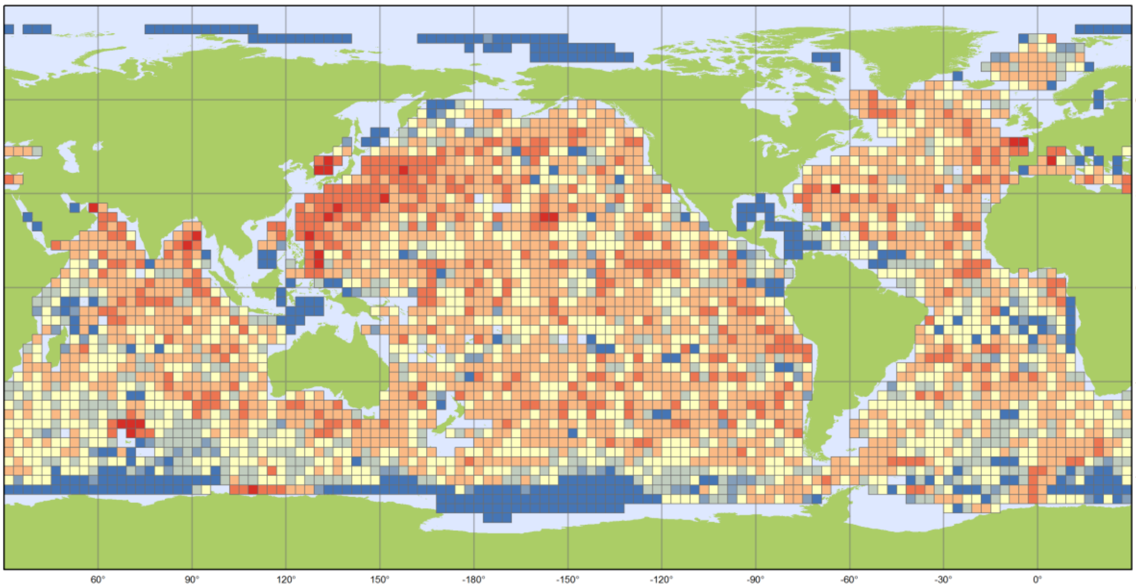


Argo **Coverage - 2007** **2007**

Average of monthly observations distributed at GDACs over calendar year

- 0.00 (432)
- 0.01 - 1.00 (96)
- 1.01 - 2.00 (441)
- 2.01 - 3.00 (987)
- 3.01 - 6.00 (1367)
- 6.01 - 15.00 (305)
- > 15 (20)

Generated by www.jcommops.org, 27/07/2016

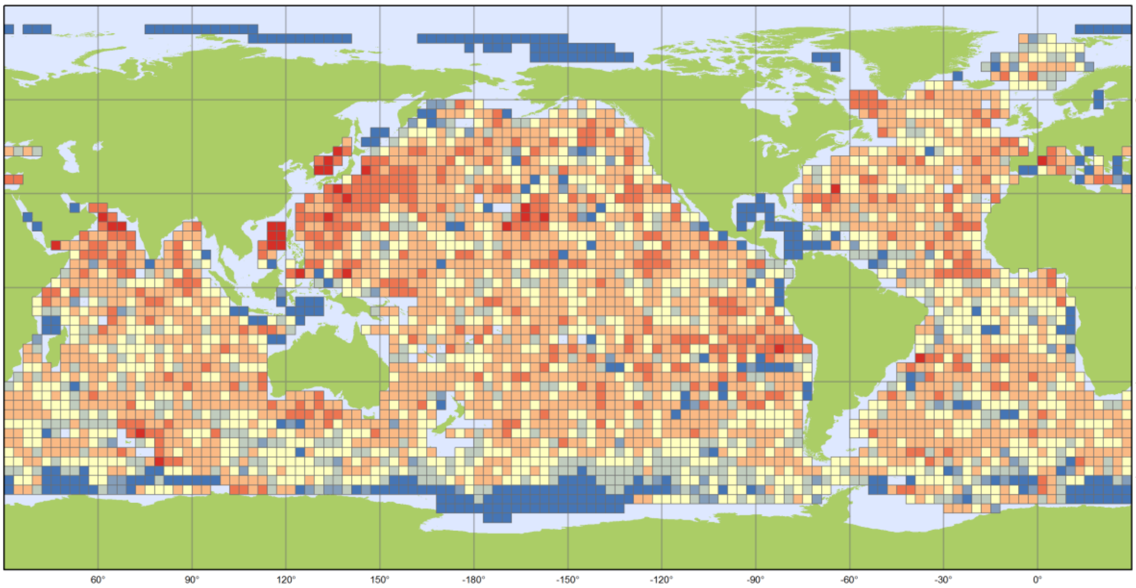


Argo **Coverage - 2008** **2008**

Average of monthly observations distributed at GDACs over calendar year

0.00 (388) | 1.01 - 2.00 (402) | 3.01 - 6.00 (1426) | > 15 (24)
0.01 - 1.00 (84) | 2.01 - 3.00 (915) | 6.01 - 15.00 (409)

Generated by www.jcommops.org, 27/07/2016

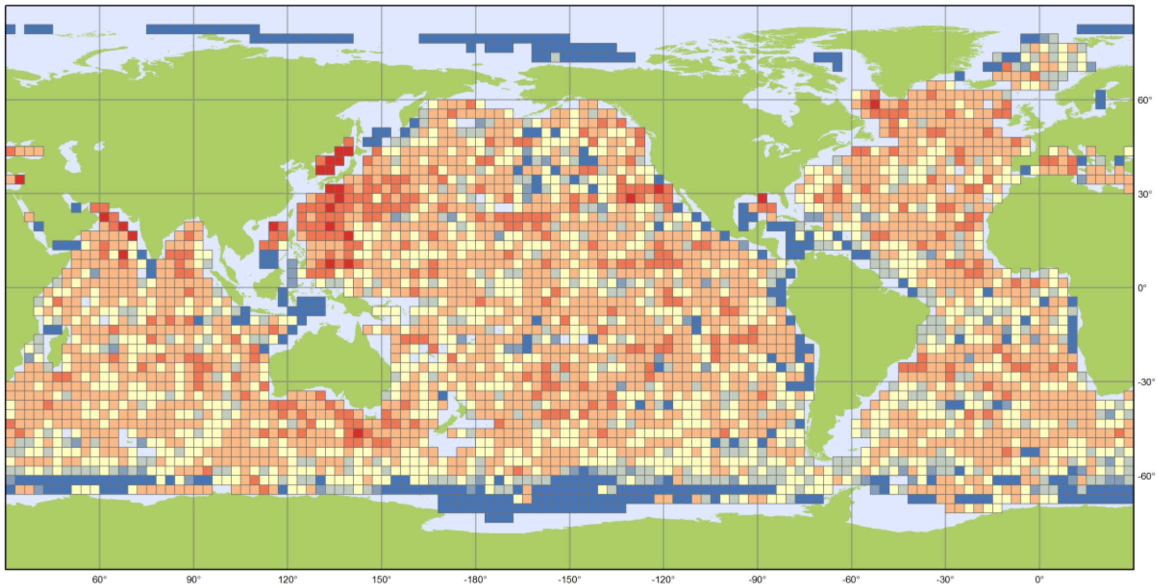


Argo **Coverage - 2009** **2009**

Average of monthly observations distributed at GDACs over calendar year

0.00 (352) | 1.01 - 2.00 (381) | 3.01 - 6.00 (1486) | > 15 (30)
0.01 - 1.00 (80) | 2.01 - 3.00 (912) | 6.01 - 15.00 (407)

Generated by www.jcommops.org, 27/07/2016

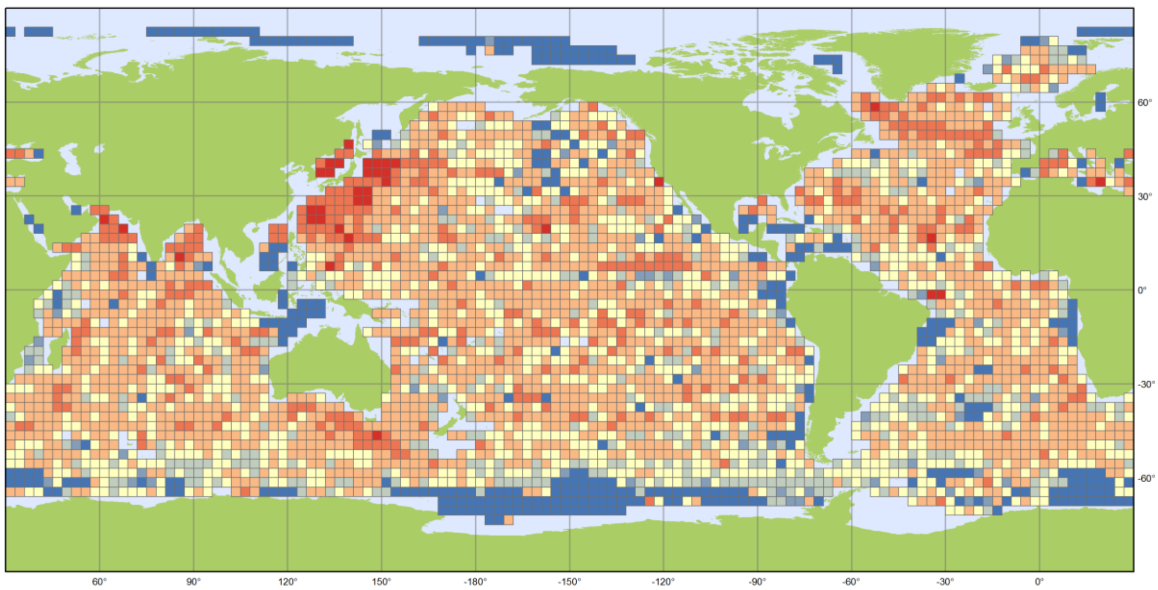


Argo **Coverage - 2010** **2010**

Average of monthly observations distributed at GDACs over calendar year

0.00 (369)
0.01 - 1.00 (67)
1.01 - 2.00 (355)
2.01 - 3.00 (919)
3.01 - 6.00 (1588)
6.01 - 15.00 (325)
> 15 (25)

Generated by www.jcommops.org, 29/07/2016

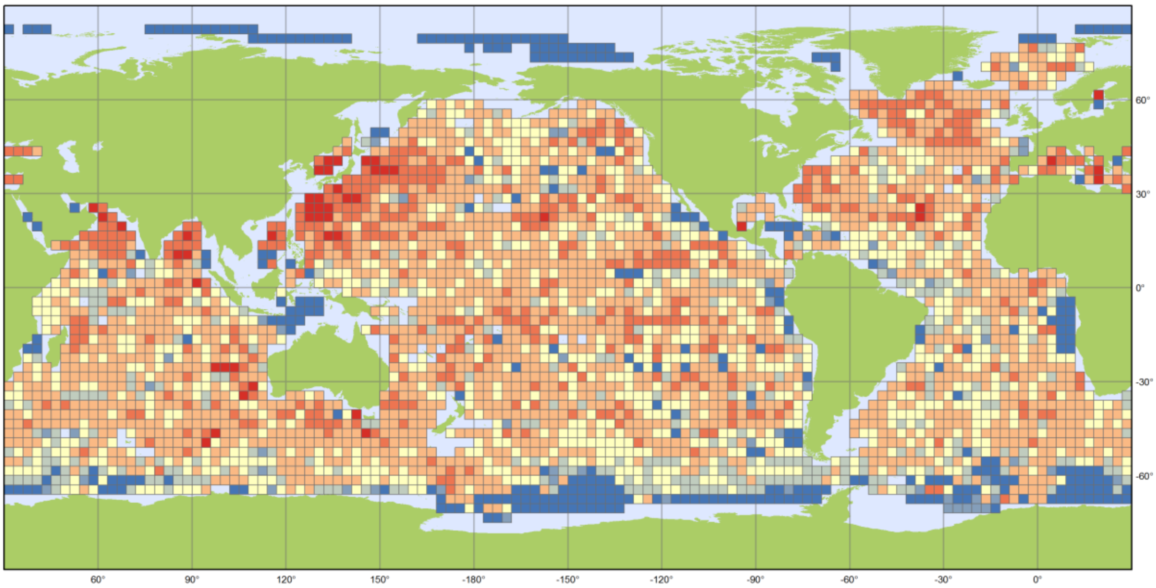


Argo **Coverage - 2011** **2011**

Average of monthly observations distributed at GDACs over calendar year

0.00 (379)
0.01 - 1.00 (59)
1.01 - 2.00 (350)
2.01 - 3.00 (875)
3.01 - 6.00 (1572)
6.01 - 15.00 (378)
> 15 (35)

Generated by www.jcommops.org, 29/07/2016

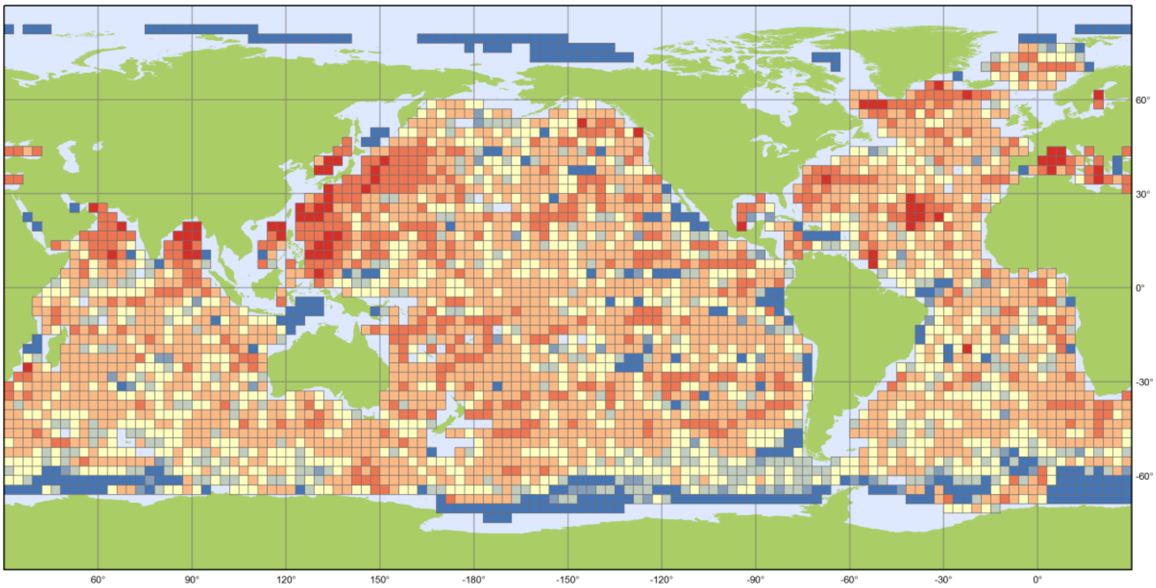


Argo **Coverage - 2012** **2012**

Average of monthly observations distributed at GDACs over calendar year

0.00 (340) | 1.01 - 2.00 (326) | 3.01 - 6.00 (1599) | > 15 (47)
0.01 - 1.00 (58) | 2.01 - 3.00 (796) | 6.01 - 15.00 (482)

Generated by www.jcommops.org, 29/07/2016

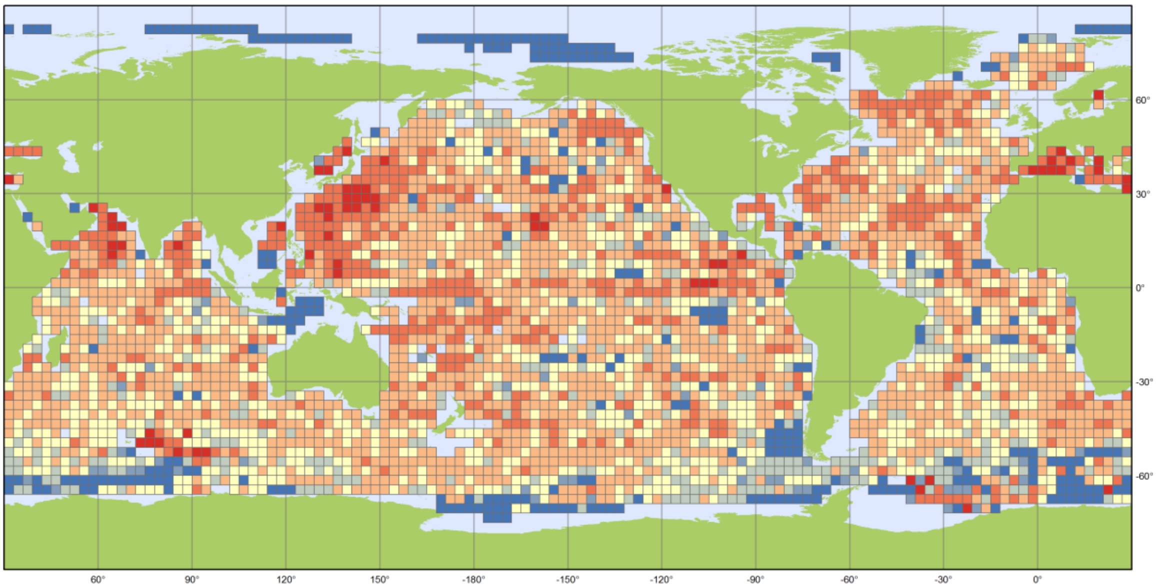


Argo **Coverage - 2013** **2013**

Average of monthly observations distributed at GDACs over calendar year

0.00 (343) | 1.01 - 2.00 (315) | 3.01 - 6.00 (1549) | > 15 (67)
0.01 - 1.00 (59) | 2.01 - 3.00 (819) | 6.01 - 15.00 (496)

Generated by www.jcommops.org, 29/07/2016

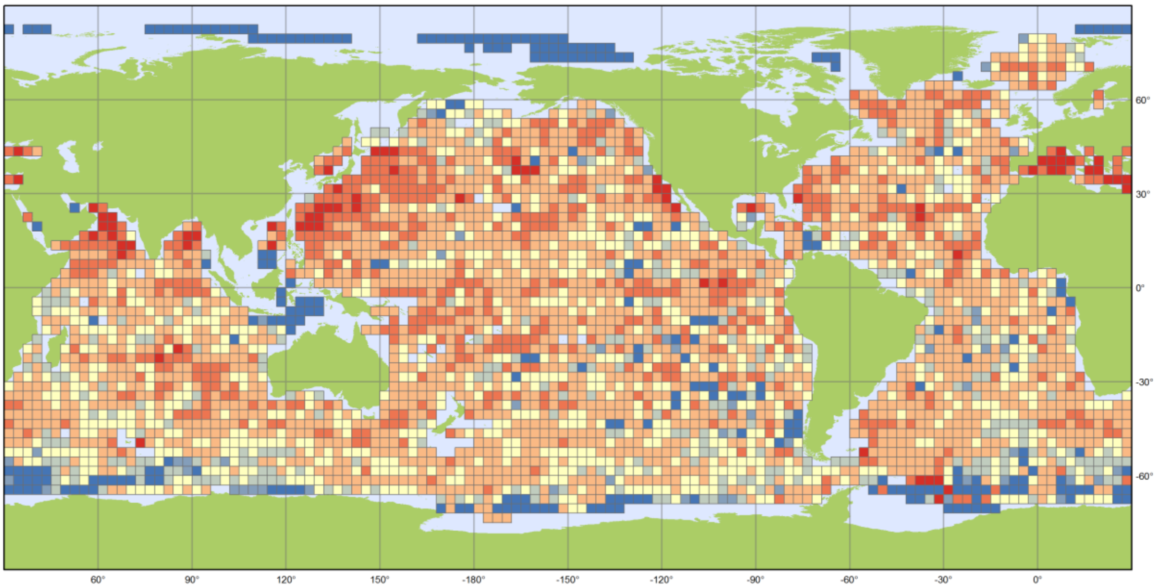


Argo — **Coverage - 2014** — **2014**

Average of monthly observations distributed at GDACs over calendar year

0.00 (303)	1.01 - 2.00 (330)	3.01 - 6.00 (1486)	> 15 (66)
0.01 - 1.00 (70)	2.01 - 3.00 (800)	6.01 - 15.00 (593)	

Generated by www.jcommops.org, 29/07/2016

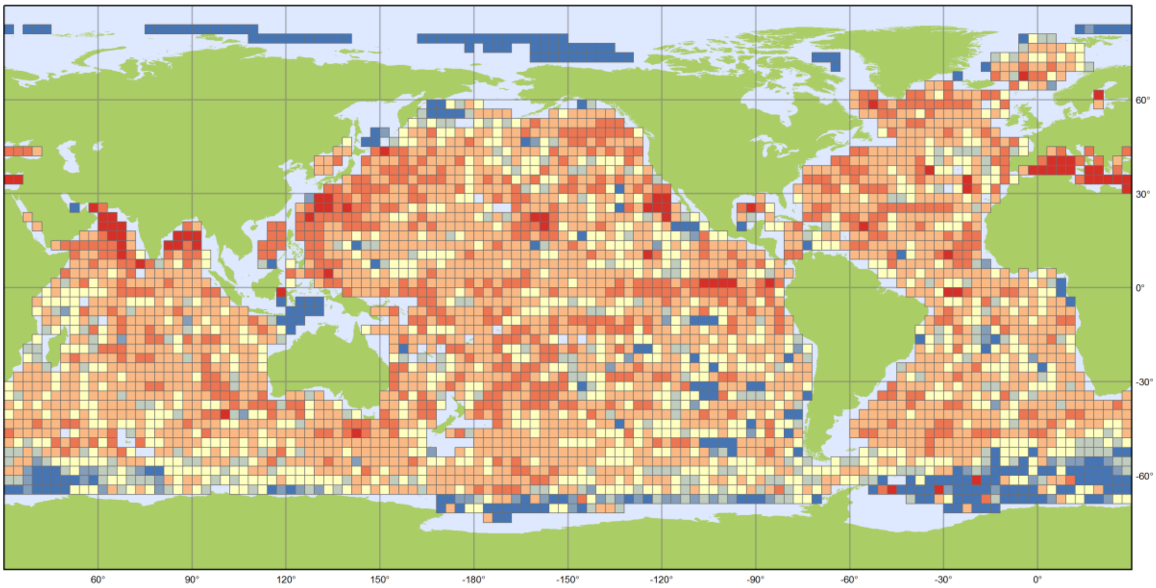


Argo — **Coverage - 2015** — **2015**

Average of monthly observations distributed at GDACs over calendar year

0.00 (266)	1.01 - 2.00 (302)	3.01 - 6.00 (1598)	> 15 (74)
0.01 - 1.00 (53)	2.01 - 3.00 (753)	6.01 - 15.00 (602)	

Generated by www.jcommops.org, 29/07/2016

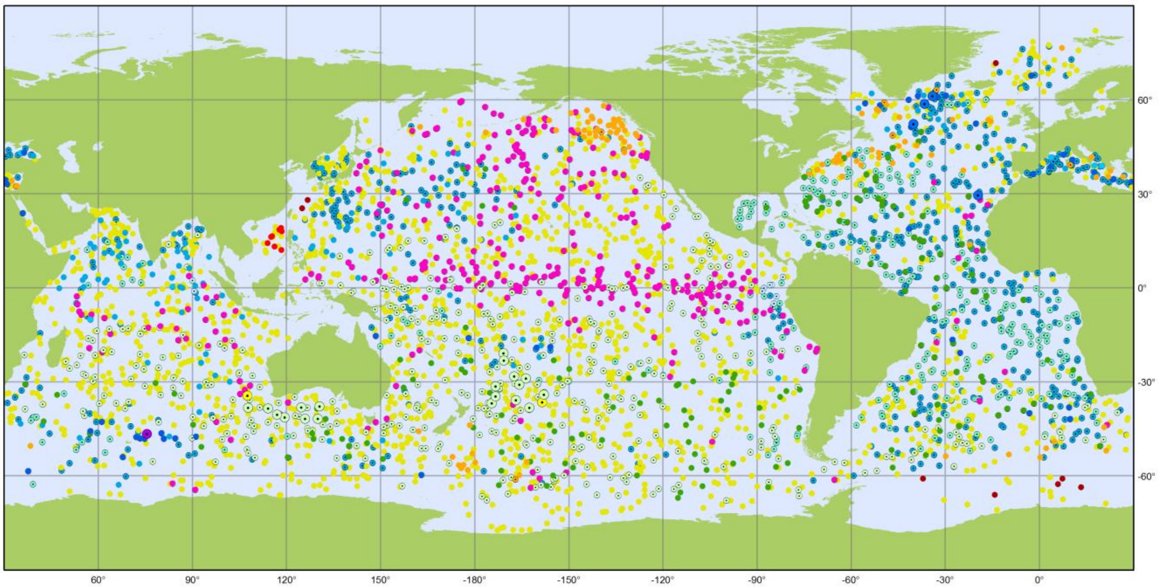


Argo **Coverage - 2016** **2016**

Average of monthly observations distributed at GDACs over calendar year

0.00 (264)
0.01 - 1.00 (67)
1.01 - 2.00 (265)
2.01 - 3.00 (743)
3.01 - 6.00 (1634)
6.01 - 15.00 (600)
> 15 (75)

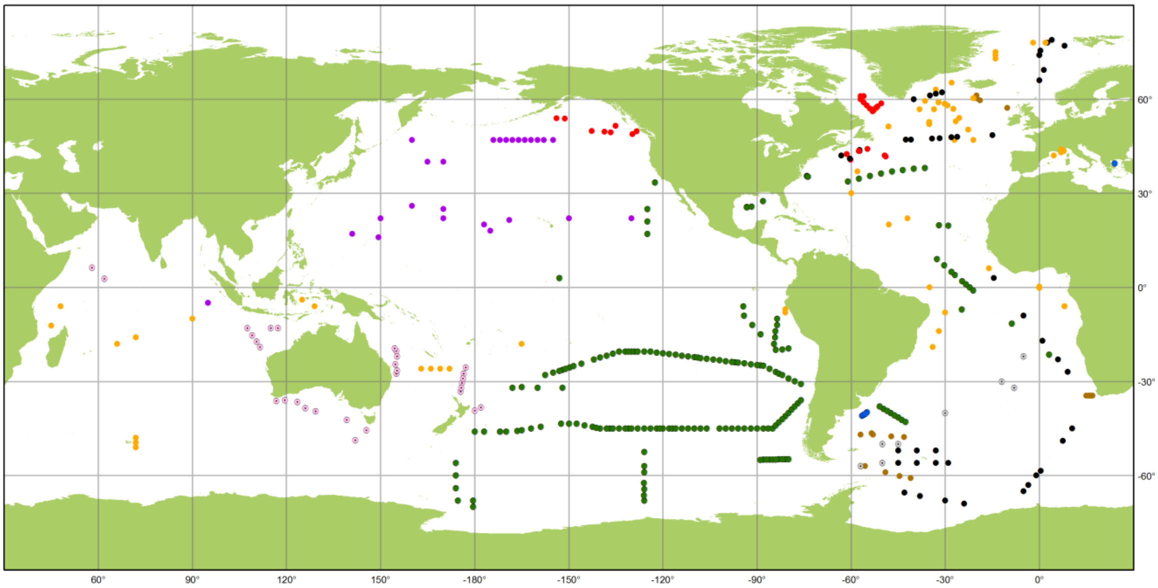
Generated by www.jcommops.org, 10/01/2017



Argo **Models** **February 2017**

APEX_D (2)
APEX (1881)
PROVOR (107)
PROVOR_II (6)
PROVOR_III (47)
ARVOR (535)
ARVOR_C (2)
ARVOR_D (4)
NAVIS_A (361)
NOVA (101)
DOVA (8)
NEMO (8)
NINJA_D (1)
SOLO (97)
SOLO_W (74)
SOLO_D (19)
S2A (285)
S2X (7)
SOLO_II (414)
HM2000 (8)

Generated by www.jcommops.org, 02/03/2017



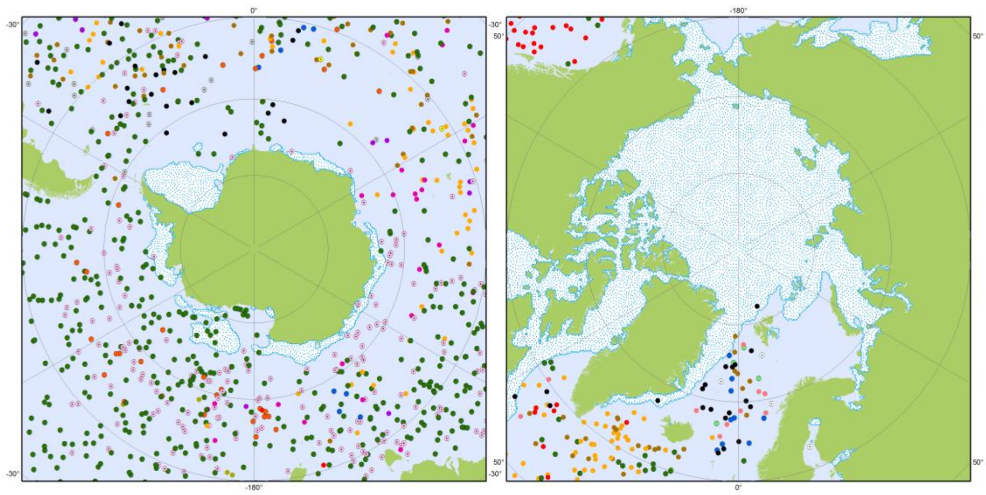
Argo | **National Deployment Plans** | **February 2017**

Deployment date ≥ today

AUSTRALIA (30) · EUROPE (5) · GERMANY (46) · NETHERLANDS (8) · USA (185)

CANADA (32) · FRANCE (75) · JAPAN (26) · UK (17)

Generated by www.jcommops.org, 02/03/2017



Argo | **National contributions** | **February 2017**

Latest location of operational floats (data distributed within the last 30 days)

ARGENTINA (2) · FRANCE (56) · NETHERLANDS (16)

AUSTRALIA (190) · GERMANY (24) · NEW ZEALAND (4)

BRAZIL (4) · INDIA (24) · UK (43)

CANADA (2) · ITALY (31) · USA (467)

EUROPE (8) · JAPAN (7)

CANADA (25) · FRANCE (43) · NORWAY (10)

EUROPE (9) · GERMANY (20) · POLAND (4)

FINLAND (4) · IRELAND (1) · UK (27)

USA (23)

Generated by www.jcommops.org, 02/03/2017

Notes