7th Euro-Argo Science Meeting
22-23 October 2019, Athens, Greece

Towards a New Phase of the Argo Program

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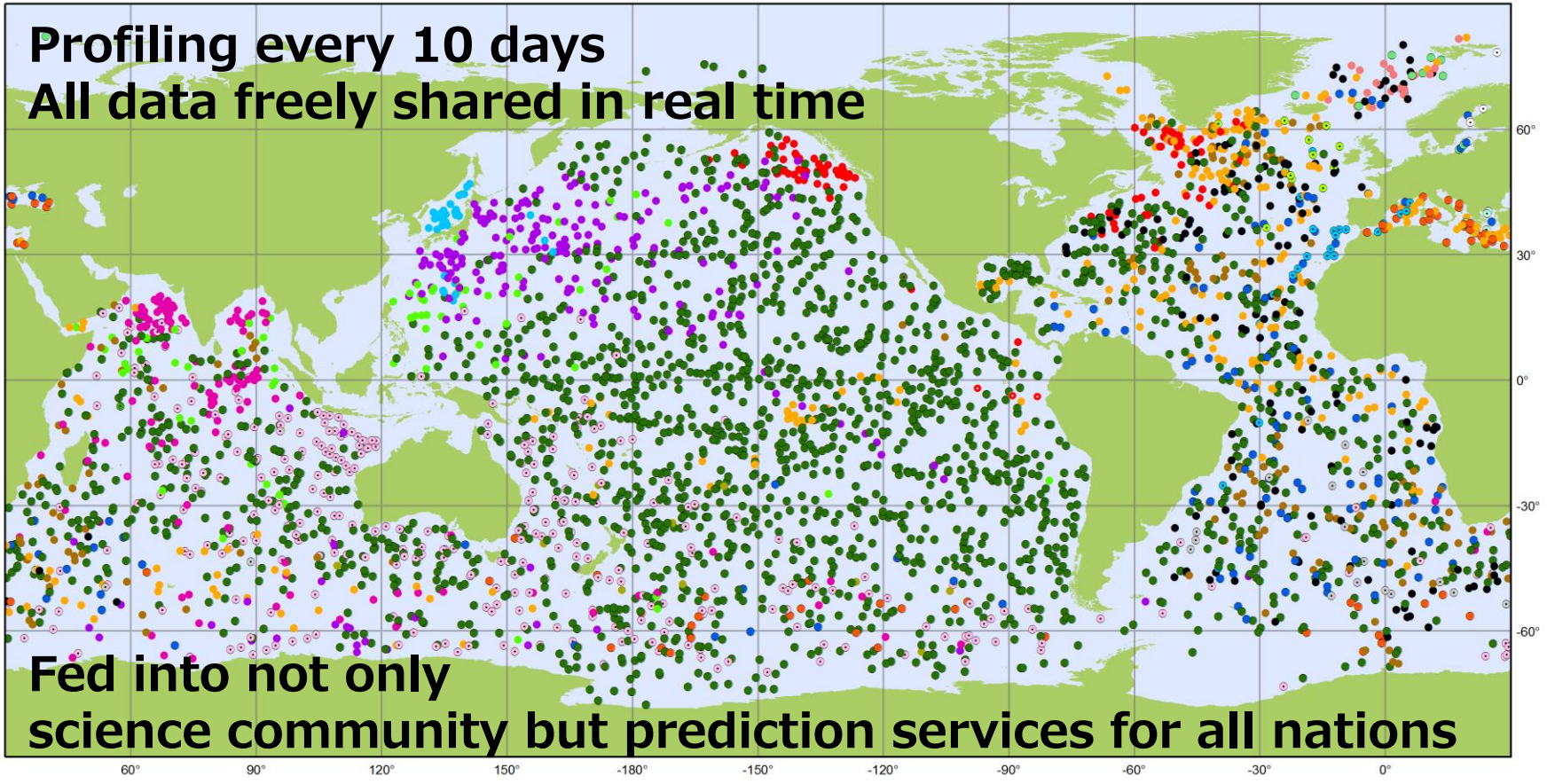
on behalf of
International Argo Steering Team

Current Status
Future Plan
Challenges for the New Phase

Current status of Argo



Argo

National contributions - 3867 Operational Floats

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

September 2019

AUSTRALIA (338)	FINLAND (5)	INDIA (140)	KENYA (1)	NORWAY (20)	SPAIN (24)
CANADA (97)	FRANCE (282)	IRELAND (12)	MEXICO (1)	PERU (3)	UK (154)
CHINA (77)	GERMANY (155)	ITALY (69)	NETHERLANDS (22)	POLAND (11)	USA (2069)
EUROPE (124)	GREECE (4)	JAPAN (217)	NEW ZEALAND (10)	KOREA, REPUBLIC OF (33)	

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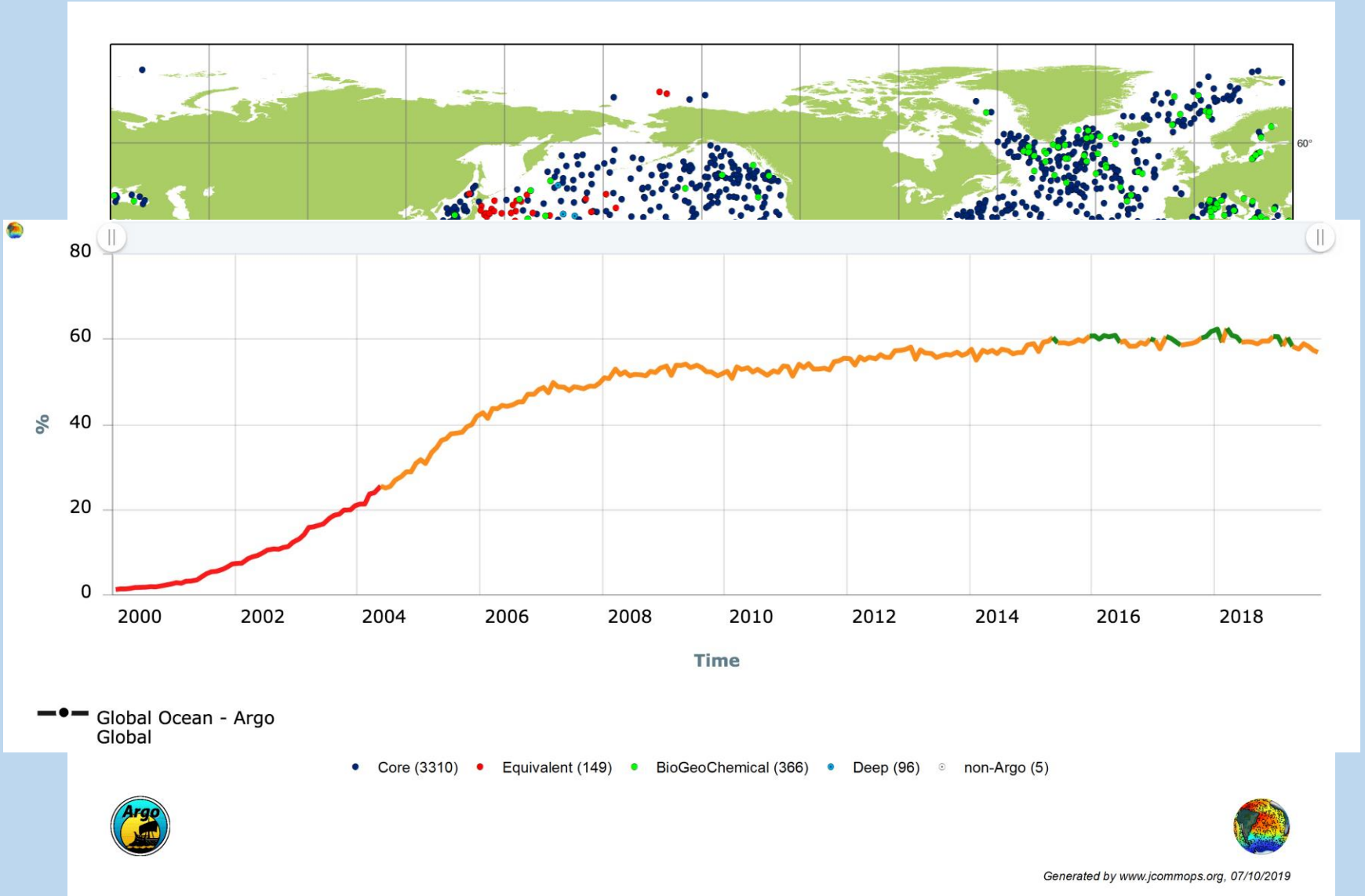
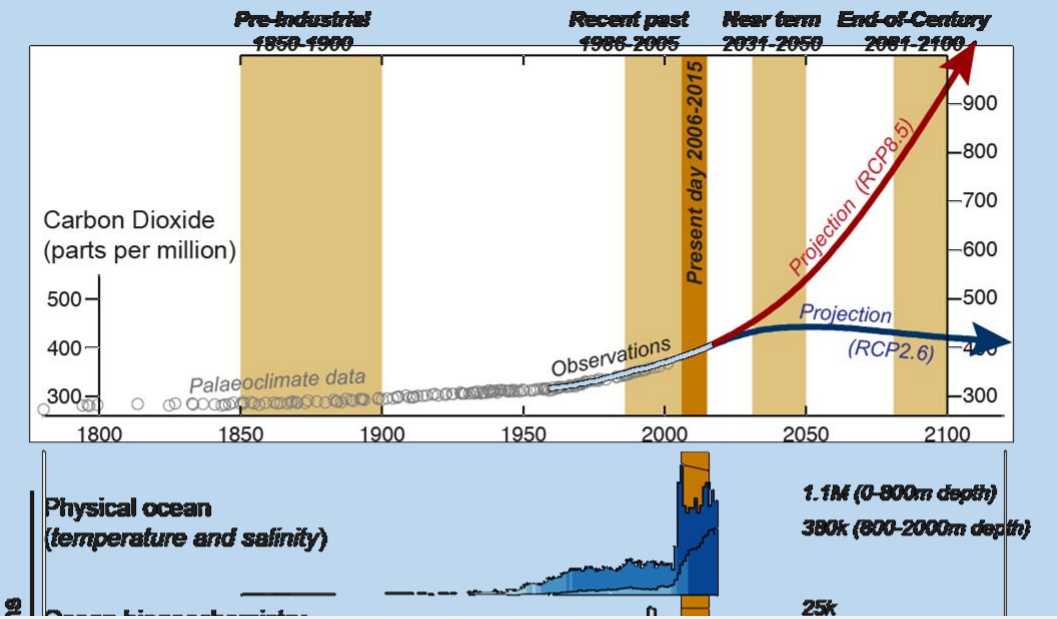
Core array remains healthy
(though deployment numbers are decreasing)



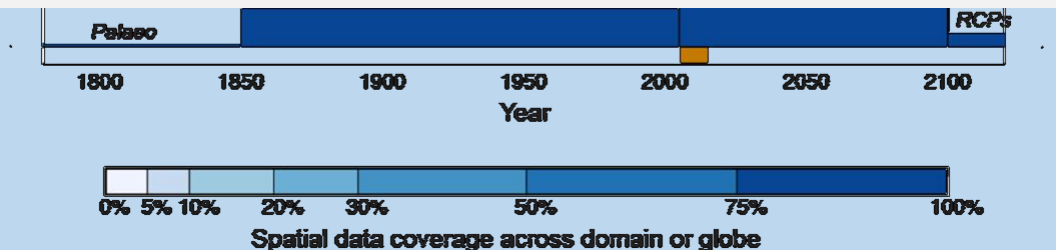
Availability of ocean and cryosphere data relative to the major time periods assessed in **IPCC SROCC**.

The amount of data available through time is shown by the heights of the time series expressed relative to the maximum annual data availability (maximum values given on plot; M = million, k = thousand).

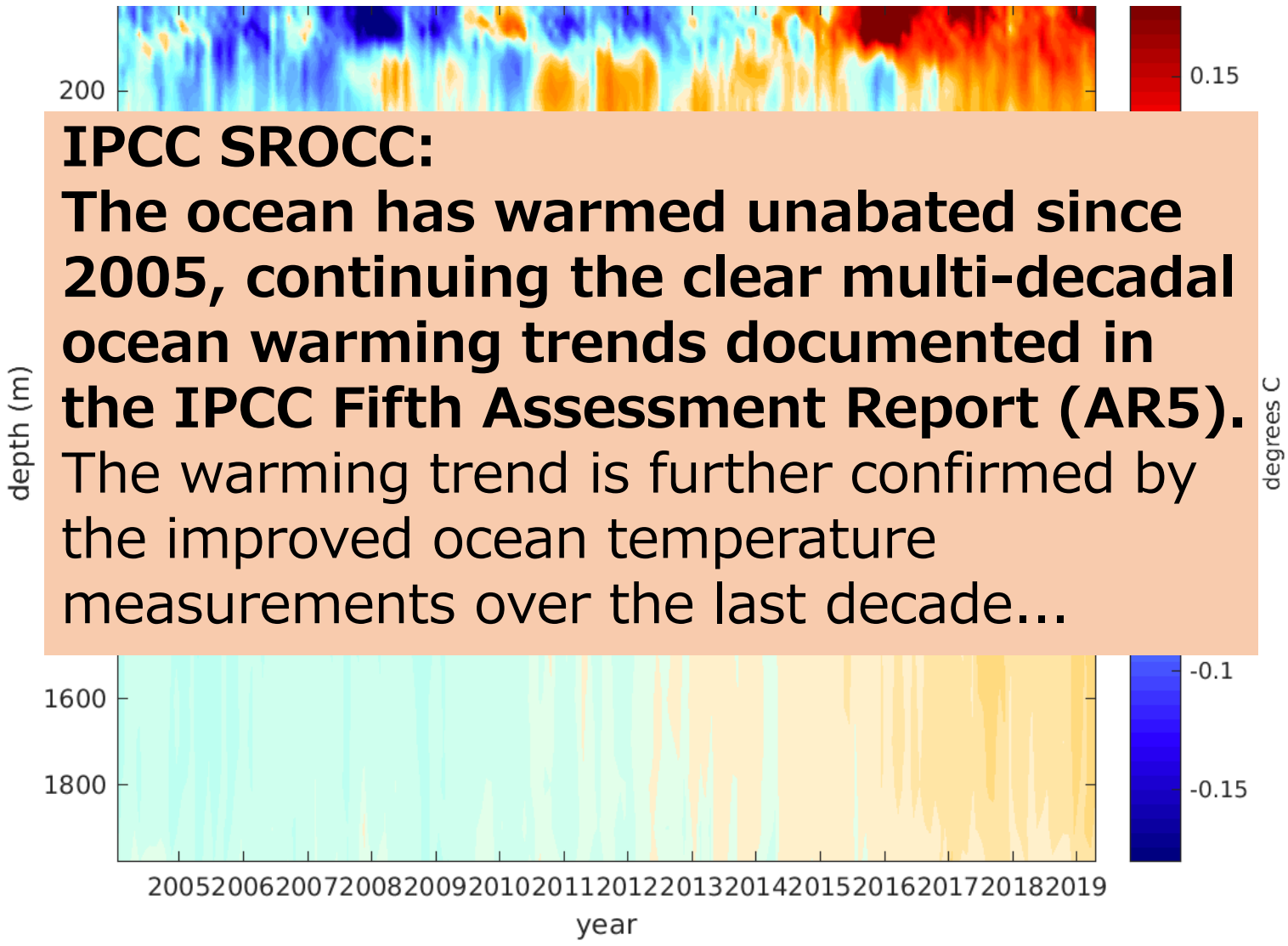
Spatial coverage of data across the globe or the relevant domain is shown by colour scale.



***In situ* ocean subsurface temperature and salinity observations** have increased in spatial and temporal coverage since the middle of the 19th century (Abraham et al., 2013), and **near global coverage (60°S-60°N) of the upper 2000 metres has been achieved since 2007 due to the international Argo network** (Riser et al., 2016).



An example of Argo's Achievements



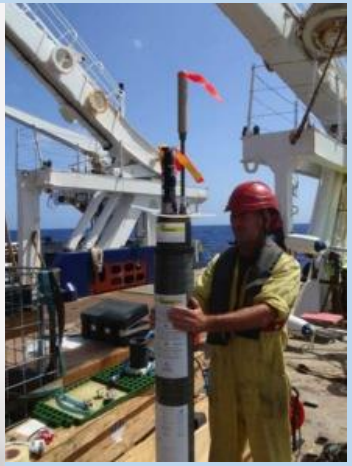
IPCC SROCC:
The ocean has warmed unabated since 2005, continuing the clear multi-decadal ocean warming trends documented in the IPCC Fifth Assessment Report (AR5).
The warming trend is further confirmed by the improved ocean temperature measurements over the last decade...

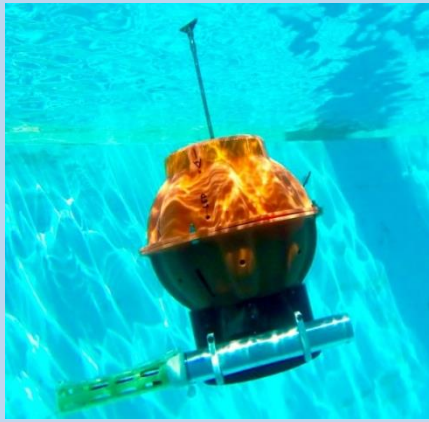
http://www.argo.ucsd.edu/global_change_analysis.html

Emerging New technologies & new requirements

- **Deep Argo**:

  Sampling variability in temperature, salinity, and ocean circulation from the sea surface to the bottom and **closing regional to global balances of heat, freshwater, and sea level**

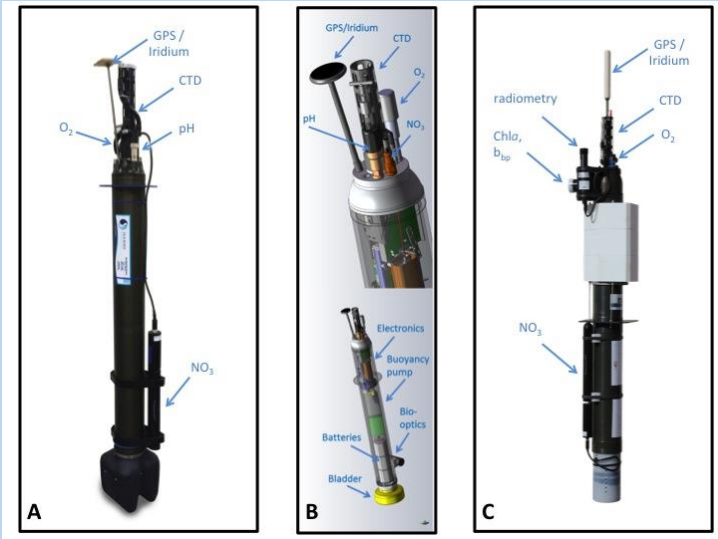




- **New platforms**
- **New CTD**

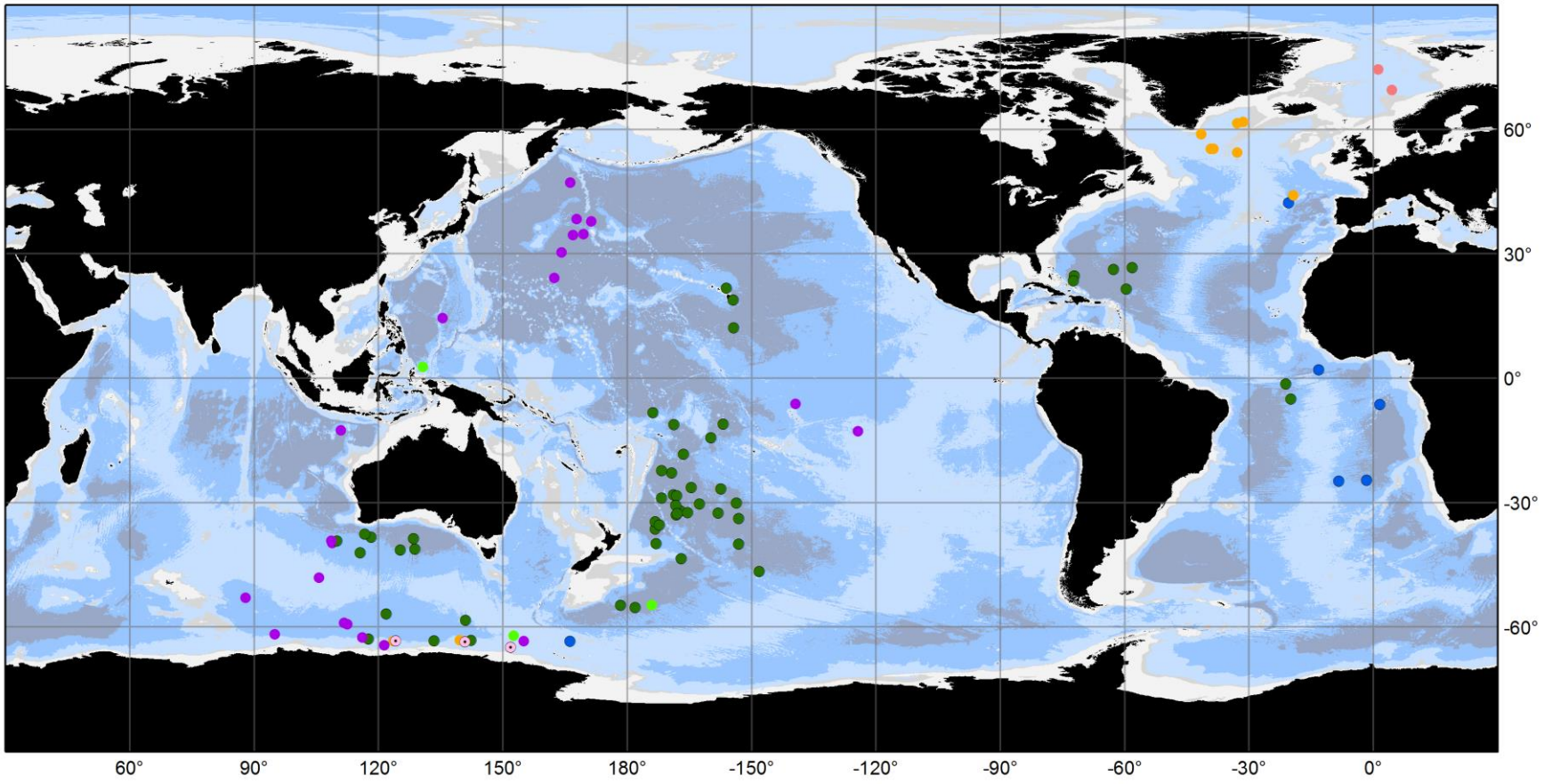
- **BGC Argo**:

  Sampling biogeochemical properties **to address Carbon Cycle, Ocean Acidification, Ocean Deoxygenation, Marine Resource Management…**



New sensors: O2, pH, Nitrate, Chl-a, …

Deep Argo pilots



Argo

National contributions - Operational Floats: 96

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

AUSTRALIA (3) · EUROPE (6) · JAPAN (21)
CHINA (3) · FRANCE (9) · NORWAY (2)
USA (52)

ETOPO2

<-5000
-5000 / -4000
-4000 / -2000
-2000 / -1000
-1000 / 0

September 2019

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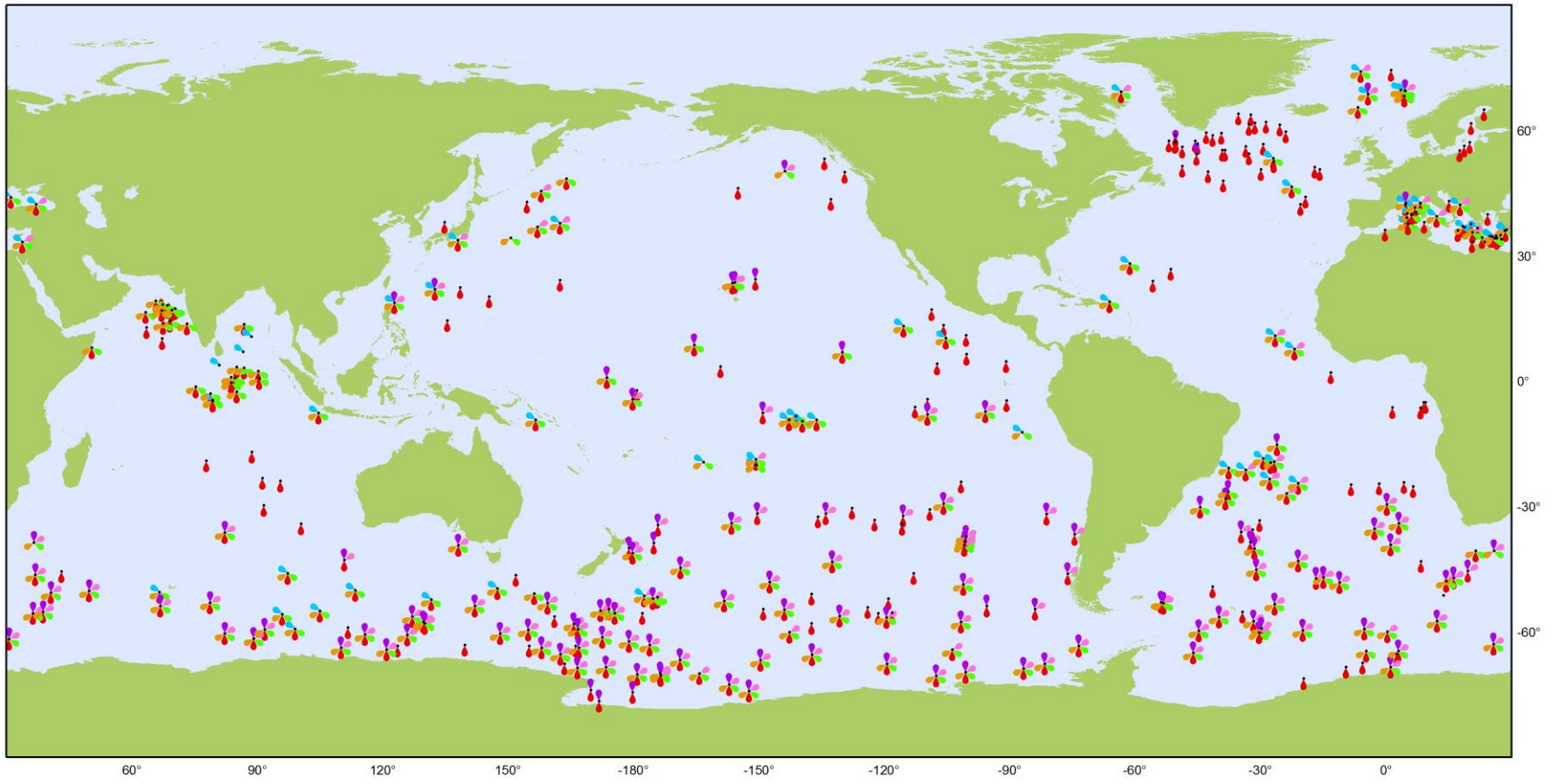
BGC Argo pilots



Biogeochemical Argo

Sensor Types

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

September 2019

- Operational Floats (366)
- Suspended particles (206)
- Downwelling irradiance (63)
- pH (136)
- Nitrate (148)
- Chlorophyll a (206)
- Oxygen (355)

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Last year we posed these questions:

Argo: The next 20 years
What should it be?
How do we get there?

We have been making some progress…

Argo: The next 20 years - What should it be?

- IOC approval of 6 new BGC parameters
- Ongoing and successful pilots of BGC and deep float arrays
- 6th Argo Science Workshop – work-shopped new design and road-tested with some users
- OceanObs'19 White Paper recommendation & poster – presented the new design
- IAST-20: approves a new design

Argo beyond 2020: a full-depth, global and multidisciplinary array

Argo beyond 2020

One array
Global in extent - full depth - multidisciplinary

- Described in the Argo OceanObs19 White Paper recommendation & poster
- Integrated 2K/deep/BGC array
- **Lynch pin** - deep and BGC floats contribute to 'core' mission – this remains a key technical challenge.
- Might be 3x current operating costs of Argo

We must continue to:

- Make a compelling case
- Pursue efficient implementation
- Entrain new partners

- Many positive comments at OO'19
- Workshop with OceanPredict at AST-21

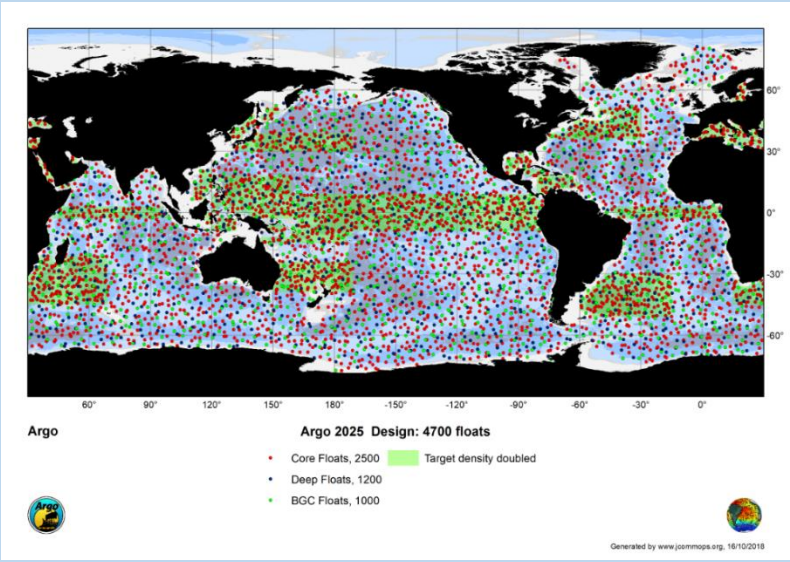
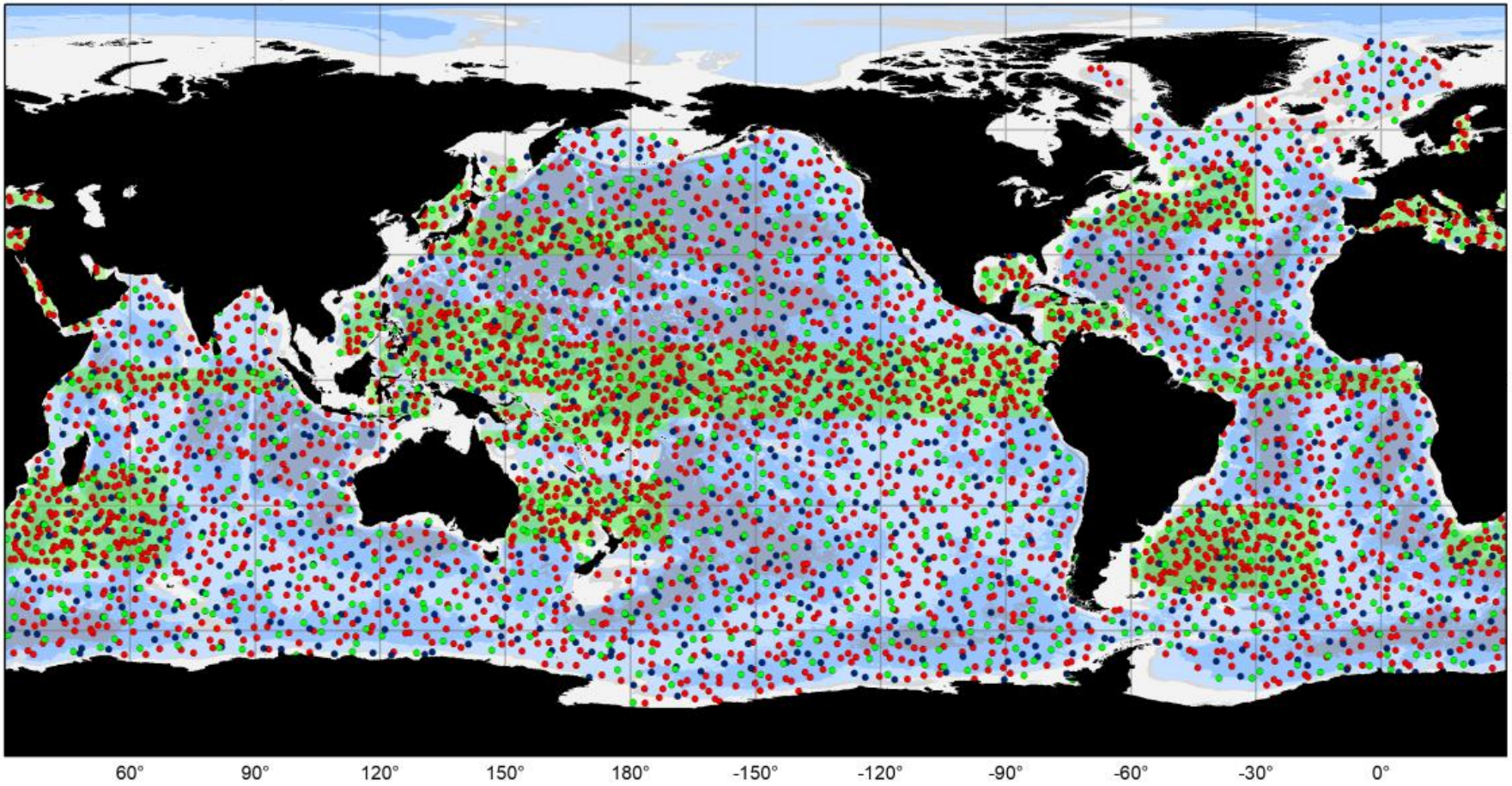


TABLE 1 | Summary of the Argo2020 design, including the required number of active floats and the present status of elements.

Design element 2x indicates doubled density (i.e., 2 floats per 3° square)	Active floats	Status
Global – Original	3000	Implemented
Global – Antarctic	290	Pilot completed; implementation not resourced
Global – Arctic	70	Pilot underway
Global – Marginal Seas (2x)	220	Implemented where regional GOOS alliances are active
Global – Total	**3580**	
Tropical Enhancement(2x)	560	W. Pacific implementation prioritized, but not resourced
Western Boundary Current Enhancement (2x)	460	Kuroshio pilot completed. Final design still in development.
Argo2020 Design	**4600**	

Where are we in terms of Argo beyond 2020?

A global, full-depth, multidisciplinary array



Argo

Argo 2020 Design: 4600 floats

Present completion %

- Core Floats, 2400 — Target density doubled — 54% of spatial enhancements
- Deep Floats, 1200 — 8%
- BGC Floats, 1000 — 15% (Nitrate sensor)

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Build up phase

Global implementations of Deep and BGC Argo are not funded yet.

We need users' advocacy for the resources to implement Argo beyond 2020.

When will we be ready to move to global implementation of the major extensions? We need to propose only what is practical and achievable.

- Antarctic sea ice zones and regional enhancements ~ extra 350 core floats per year - now
- Arctic – ice avoidance is still a work in progress, survivability rates are still unknown (a larger pilot is needed) – 2-3 years?
- Deep and BGC – float and sensor production rates? We need ~ 250 per year (with 5 year lifetime). 2-3 years?

How do we transition without compromising the core array?

% of 960/year needed deployments

- We need to be realistic to our funders what the extended missions will cost.
- It is essential that largescale pilots or test deployments do no parasitize core array funding.
- Ideally, largescale pilots should be funded independently.
- Avoid assuming that we can ‘convert’ a core hull to a BGC or Deep hull until we have proven this is true, or ensure more funding is available to cover shorter hull lifetimes.

Status of Argo enhancements

- Deep: deep pilots are expanding, progress on sensor testing and development is promising. How to manage 4000dbar/6000dbar mix is a challenge – Deep Mission Team
- Equatorial: clear recommendation of doubling (+/- 10^{o}) from TPOS2020 - implementation stalled. Possible progress soon
- WBC: design still needs work, implementation spotty
- Polar: Antarctic array has stalled ~ 50% ; Arctic pilots are increasing and some floats have over-wintered.
- BGC : regional pilots expanding, active Mission Team. EEZ issue is largely solved providing programs follow Argo guidelines. Major new US proposal is still alive, but high sensor prices are an impediment to several nations.
- Marginal Seas: progress remains spotty –largely due to EEZ and capacity issues.

Landscape for the coming decade

Argo beyond 2020 is fully aligning with GOOS 2030 Strategy.

Vision

A truly global ocean observing system that delivers the essential information needed for our sustainable development, safety, wellbeing and prosperity

Mission

To lead the ocean observing community and create the partnerships to grow an integrated, responsive and sustained observing system

An essential contribution to

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Challenges/Opportunities

- Cost – 3 x current investment
  - Increased end-user value through enhanced **end-user engagement**, **new partners** and **integration with other observing networks**
  - Stronger advocacy for **integrated global ocean observing**
- Continued sensor/platform development for efficiency
  - Collaboration with **commercial partners**
  - Linkage between **research and operational communities**
- Access to the global ocean
  - Coastal states/international **political support for EEZ clearance**
  - **inter-network coordination/collaboration/integration**
- Risk management – complex system
  - **Careful assessments and coordination**
  - **Proper governance**

Contribution of the Euro-Argo community is essential!