The Observation challenge: deep waters to coasts
View-point of a climate-focused physical oceanographer

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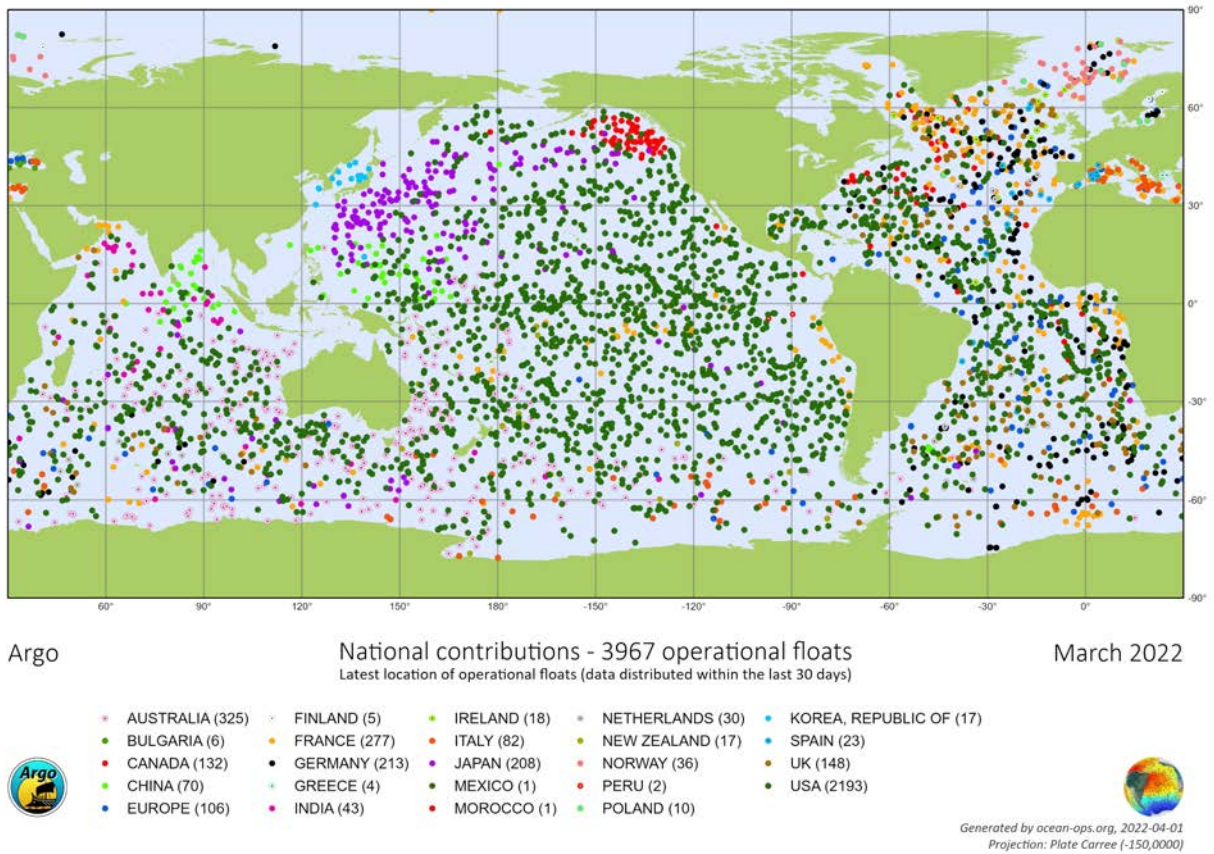
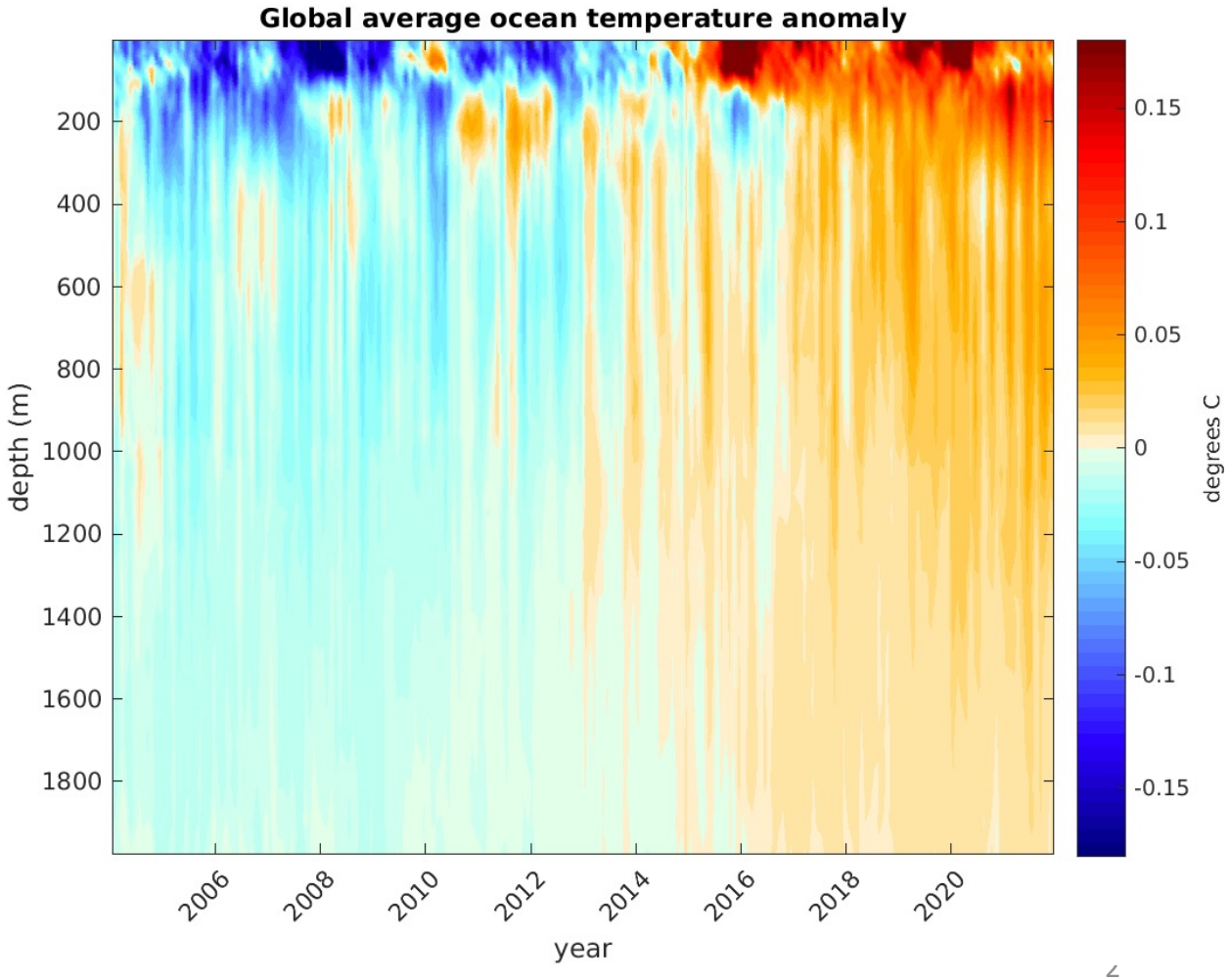
Progress? Revolution in Bluewater T/S

- We need to observe globally to understand local changes and their attribution

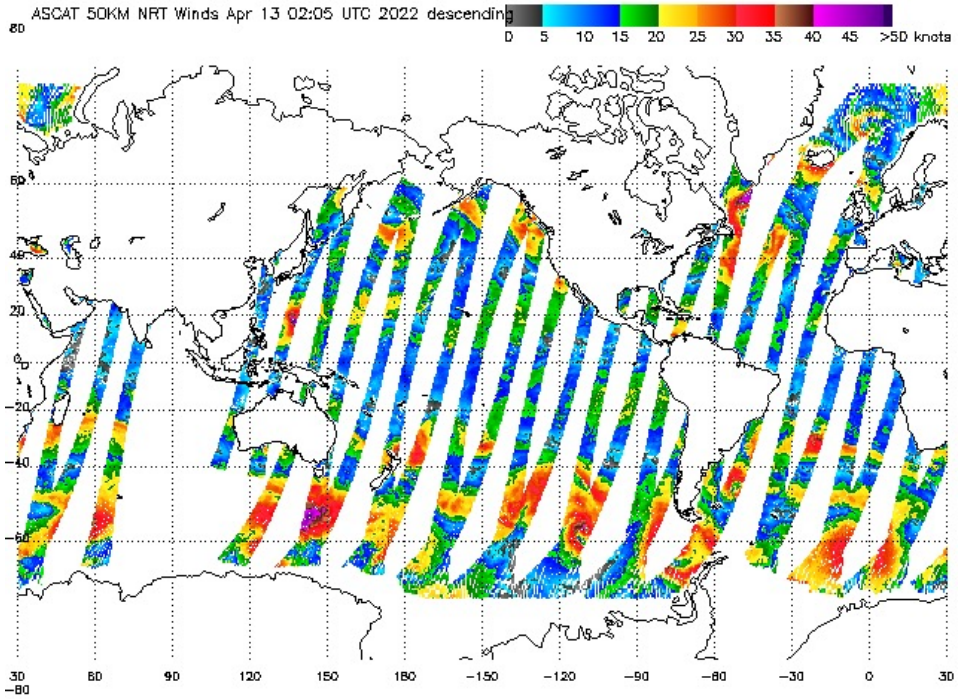




We are making progress? Critical satellite missions

Earth Observing Satellites coordinated by CEOS

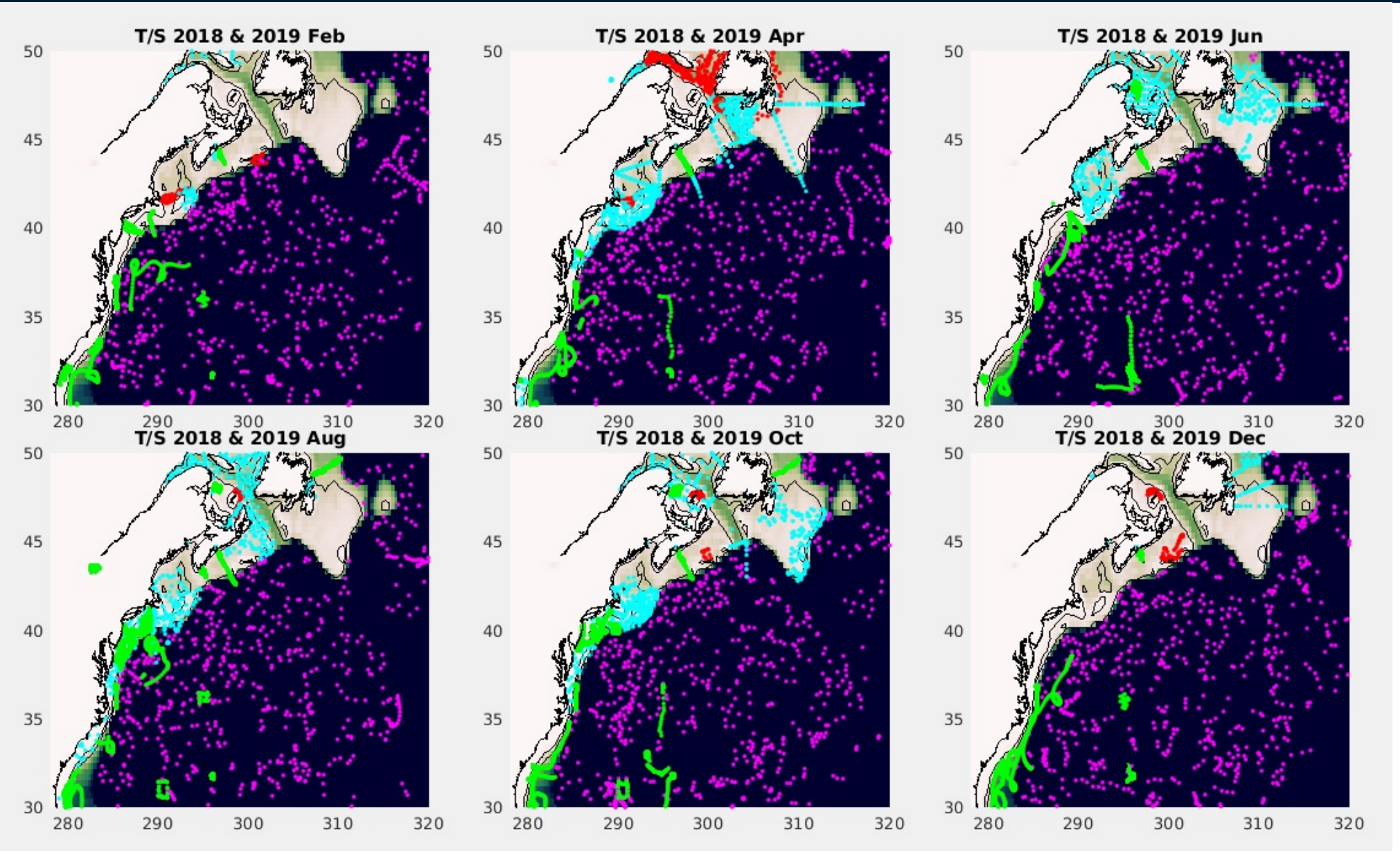
- Ocean colour radiometry
- Surface Topography
- Vector Winds
- Precipitation
- Sea Surface Temperature
- *Sea surface Salinity*



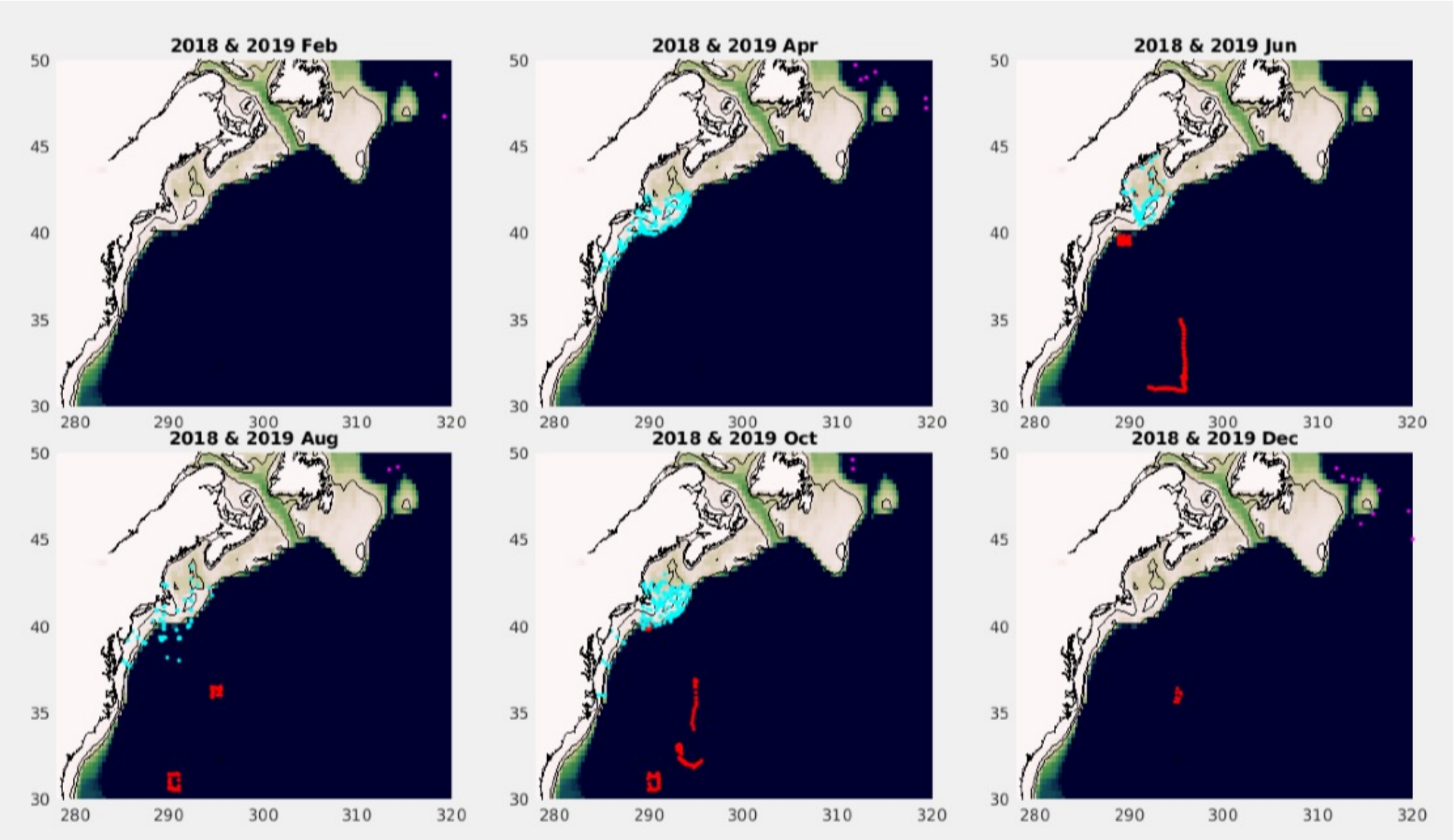
Partnered with *in situ* networks **– Integrated System**

- **surface topography/Argo**
- **vector winds/Moored Arrays**
- **Satellite SST/Surface Drifters**

T/S sampling – 2018/2019 (WOD/NCEI)



Oxygen sampling – 2018+2019 (NCEI/WOD)



Big challenges – multidisciplinary/towards coasts

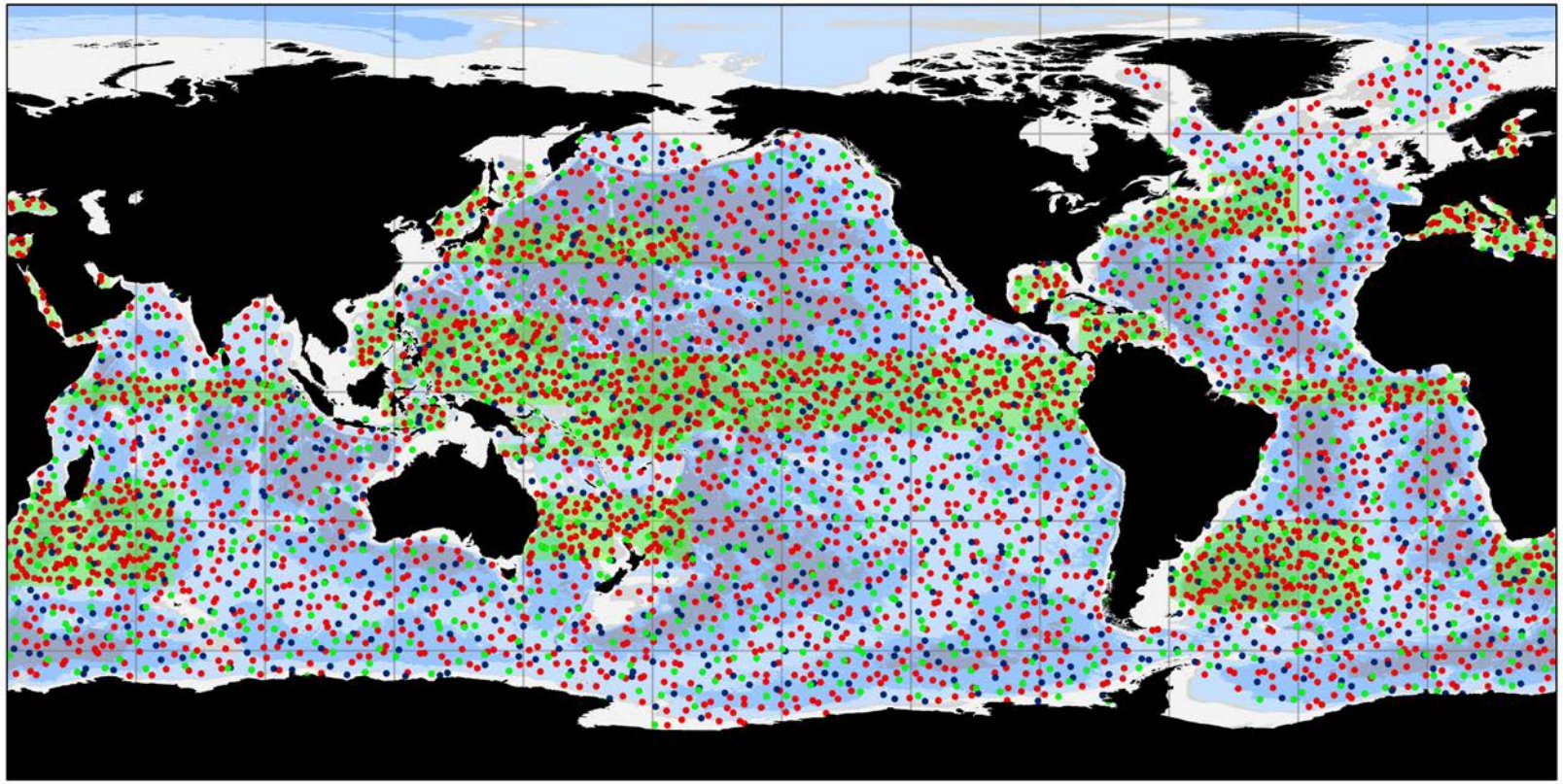
- Offshore: Sustained and deliberate broad scale BGC measurements are just beginning

- On shelves: it is possible we are going backward with the decline of regional research fleets/surveys

- Offshore sampling is being enabled by

1. Platform maturity: profiling float and glider technology
2. Sensor maturity: Low power/mass and stable BGC and optical sensors
3. A global observing design (for floats) – not sure for glider sampling?

We are making progress?



Argo

Argo Distribution - OneArgo

Argo global, full-depth, multidisciplinary design: 4700 floats

- Core Floats, 2500
- Deep Floats, 1200
- BGC Floats, 1000

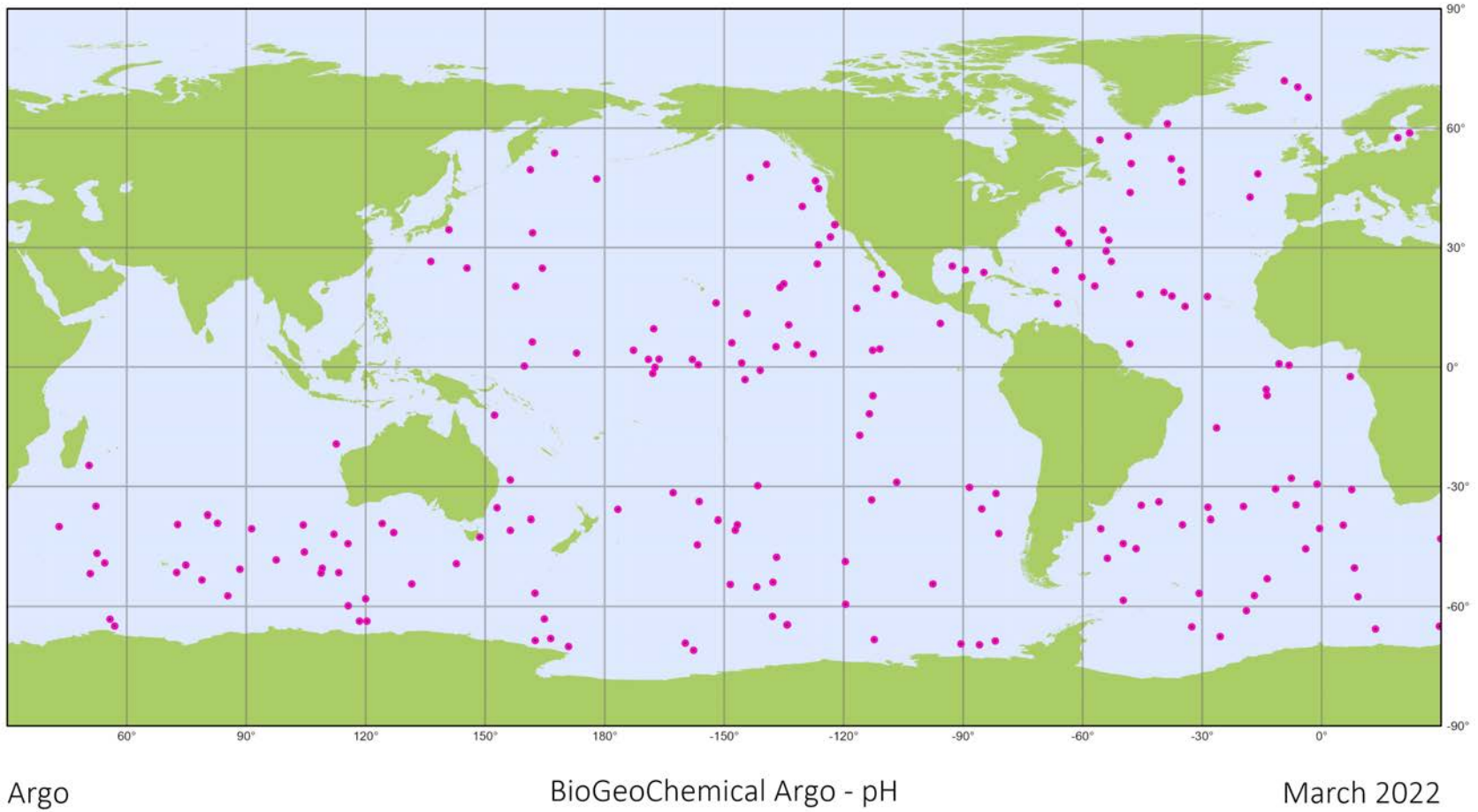
Target density doubled

Generated by ocean-ops.org, 2022-03-09
Projection: Plate Carree (-150,0000)

OneArgo Design

- 1000 6 parameter floats
- Nitrate/oxygen/pH
- Chla/CDOM
- Irradiance

Multiparameter BGC float array: nascent/not secure



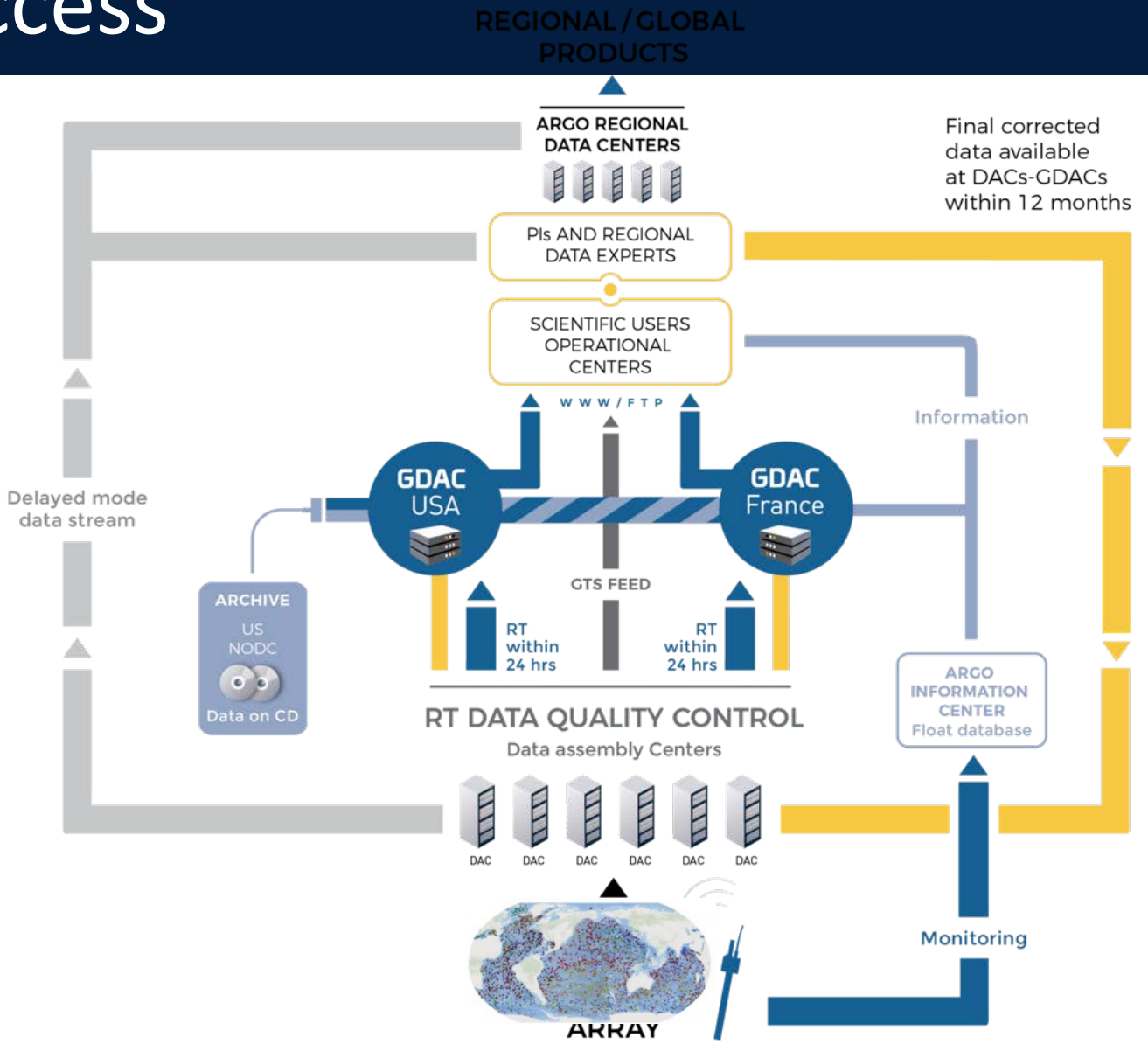
- US has 2 NSF funded global research arrays
- Other nations are struggling
- High sensor prices and supply
- lack of scale-up in new funds

Argo Data System

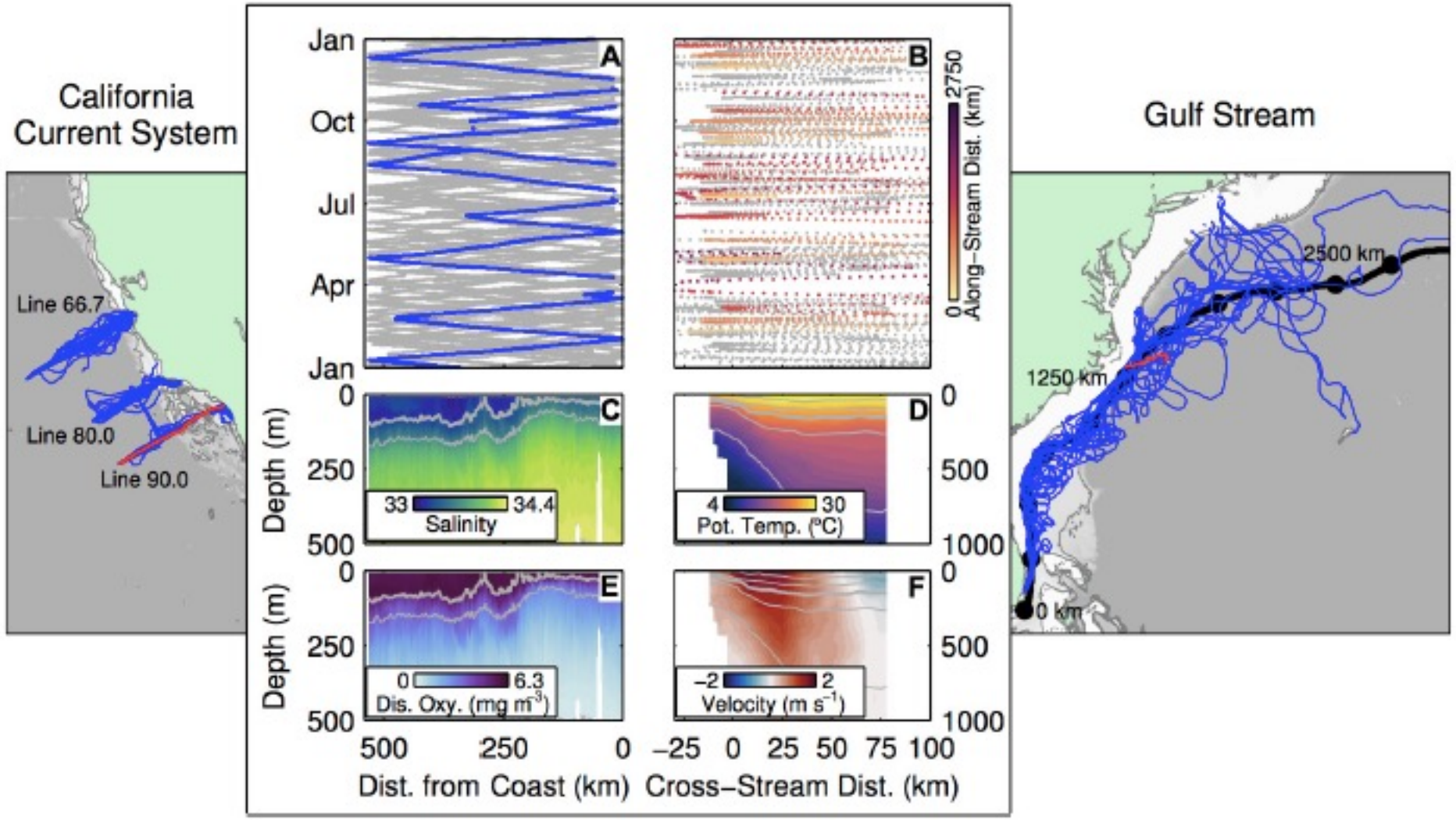
Groundbreaking
Providing near real-time and climate-quality delayed mode data.

Including meta- and technical data.

All Argo data are freely and immediately available via the internet and GTS.



Gliders: examples of deliberate/sustained



Todd et al, 2019: doi: 10.3389/fmars.2019.00423

Gliders: is there a clear sampling design for the shelf?

- What is the target space/time sampling required? Can models inform a design?
- What BGC and optical sensors should be carried?
- Can their data be easily aggregated with offshore gliders/floats sensors?
- Common standards/formats and realtime data sharing - realtime DACs or GTS distribution to enable operational uptake

*** I could not find a single site where I can download all US shelf glider data – multiple sites with multiple formats. How can the operational or reanalysis centres deal with this?

Future challenges and opportunities

- Sensors

1. high prices for CTDs/nitrate/pH
2. Dynamic error in oxgen, pH, etc
3. calibrating optics and interpreting them

- Platforms

1. As access to ship-time decreases, reliance on autonomous platforms will increase.
2. Drive up longevity (power efficiency) and reliability
3. Build capacity in more teams

- Communications

1. Shelf/offshore – expensive still (compression or data buses)
2. Inshore – can use cell networks

Future challenges and opportunities

- Bio-Optics

1. Cusp of a revolution in autonomous remote biological imaging
2. How can this be deployed on more platforms?
3. Sampling Design: Time and space scales to resolve?
4. Can a modern data system be put in place ahead of time ?

- Bio-Acoustics

1. Potential to drastically increase volumes sensed, depth and time resolution of observations
2. Sampling Design: Time and space scales to resolve?
3. As for optics, needs sophisticated processing and in situ validation system

- eDNA - presently requires sampling/obtaining materials, but might change

Future challenges and opportunities

frontiers in Marine Science

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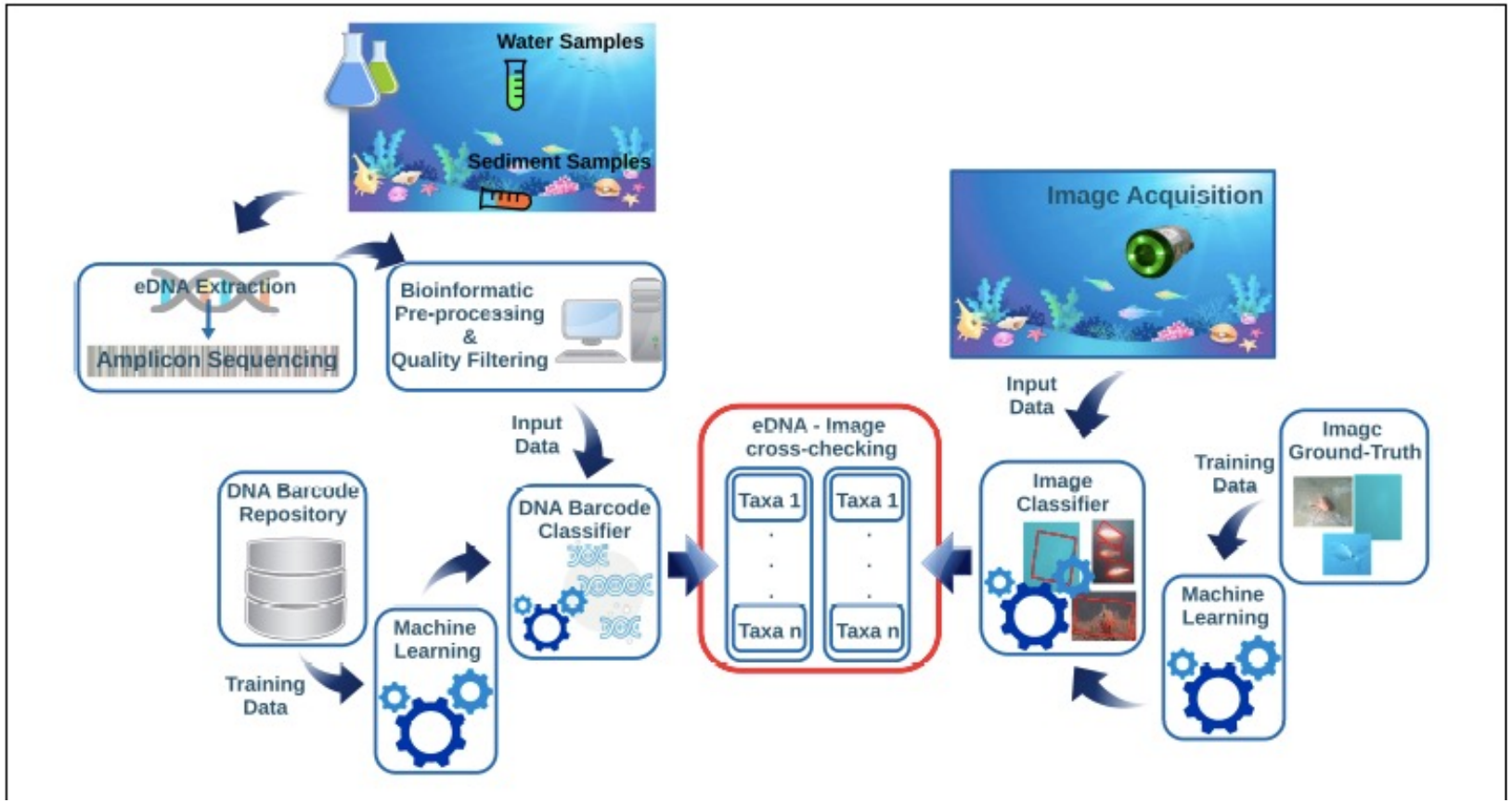

Framing Cutting-Edge Integrative Deep-Sea Biodiversity Monitoring via Environmental DNA and Optoacoustic Augmented Infrastructures

Sergio Stefanni[1], Luca Mirimin[2], David Stanković[3,4], Damianos Chatzievangelou[5], Lucia Bongiorni[6], Simone Marini[1,7], Maria Vittoria Modica[1], Elisabetta Manea[6], Federico Bonofiglio[7], Joaquin del Rio Fernandez[8], Neven Cukrov[9], Ana Gavrilović[10], Fabio C. De Leo[11,12] and Jacopo Aguzzi[1,5*]*

Summary

- We have made a lot of progress, particularly in the blue water – synergies between satellites/in situ systems.
- Scaling up BGC coverage is a major immediate challenge - $$s, sensor prices and availability
- T/S coverage on shelves remains uneven – could a more deliberate glider array design and implementation help? Should there be a backbone?
- Data distribution/management might still be a barrier to state estimation/prediction
- Optical imaging and acoustic sensing might represent the two primary opportunities to revolutionize biological sampling. How can we expedite their deployments on various platforms and quickly enable modern data systems?