

New Opportunities from BGC Argo for Global Mapping of Ocean Biogeochemical Properties

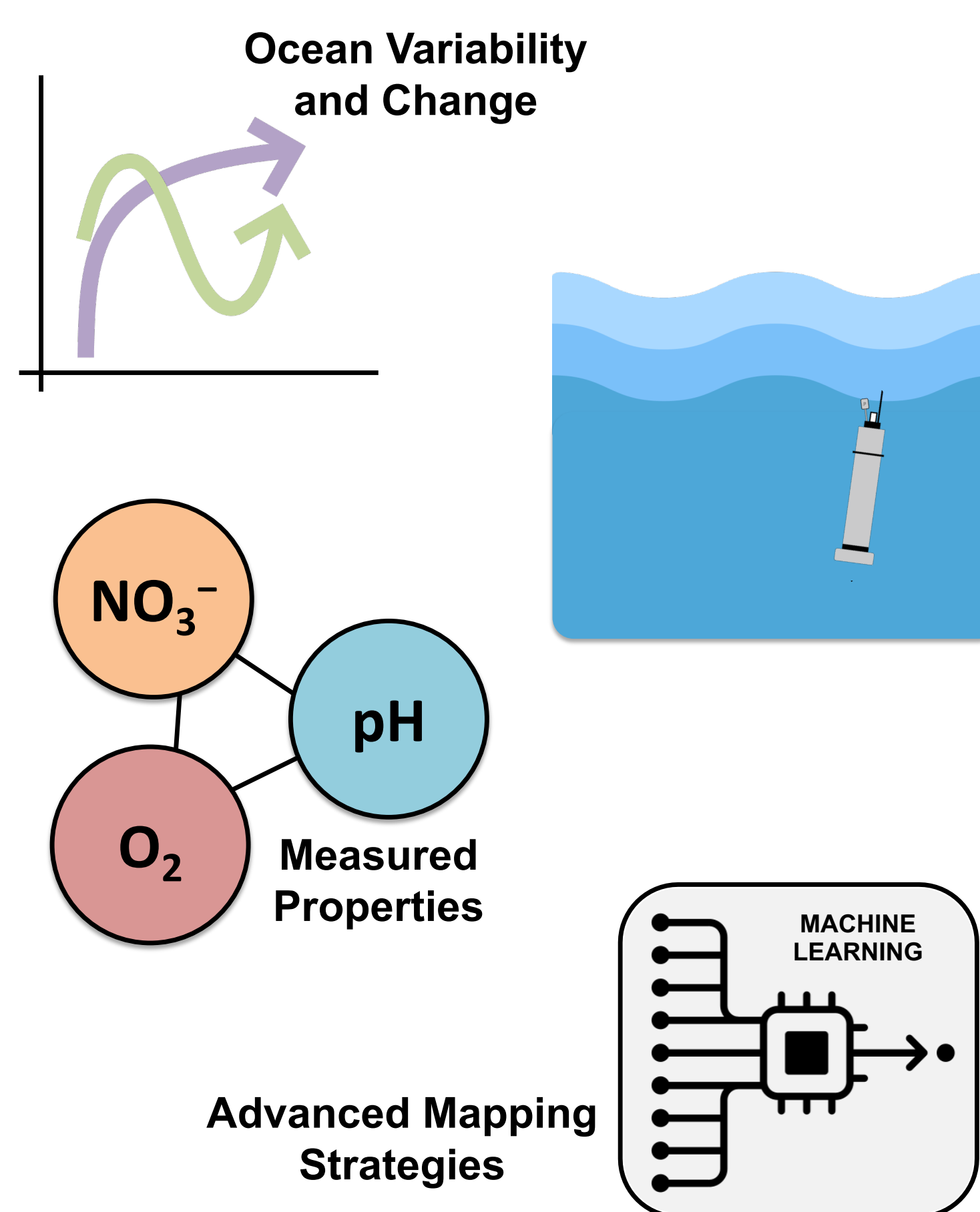
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Introduction

- The global ocean is poised for a variety of changes associated with anthropogenic carbon emissions.
- Whereas outcomes like ocean warming and surface acidification are relatively well-constrained, others such as changes to the biological pump, the loss of interior ocean oxygen, and shifts in surface primary production are less certain.
- Observation-based products will be a critical resource for studying these outcomes and providing constraints for ocean model projections.
- The continuing expansion of the global biogeochemical Argo array has facilitated efforts to map ocean interior biogeochemistry over space and time.

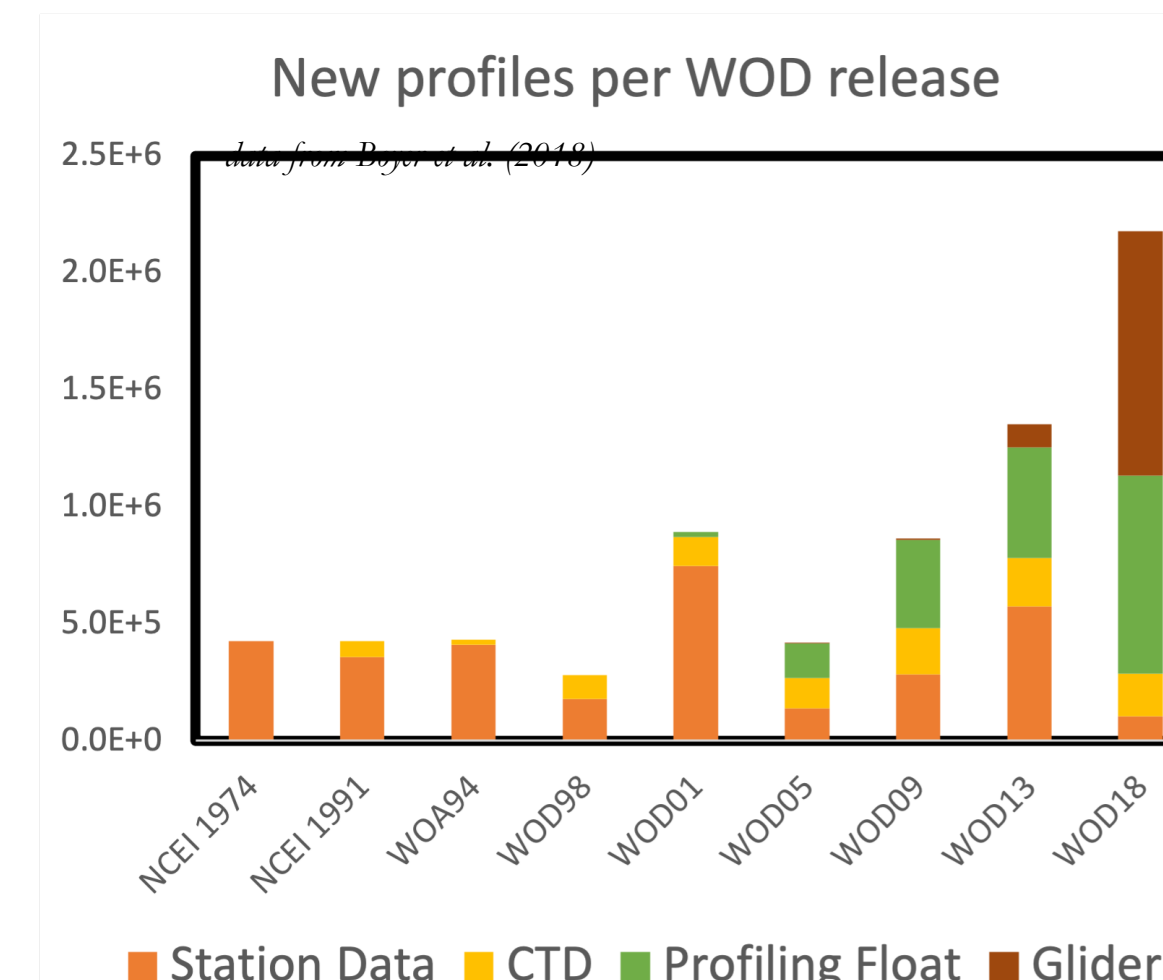


A Shift in Data Sources

Since the turn of the century, sensors on profiling floats and other autonomous platforms (carefully calibrated to discrete measurements) have been a significant source of ocean biogeochemical data.

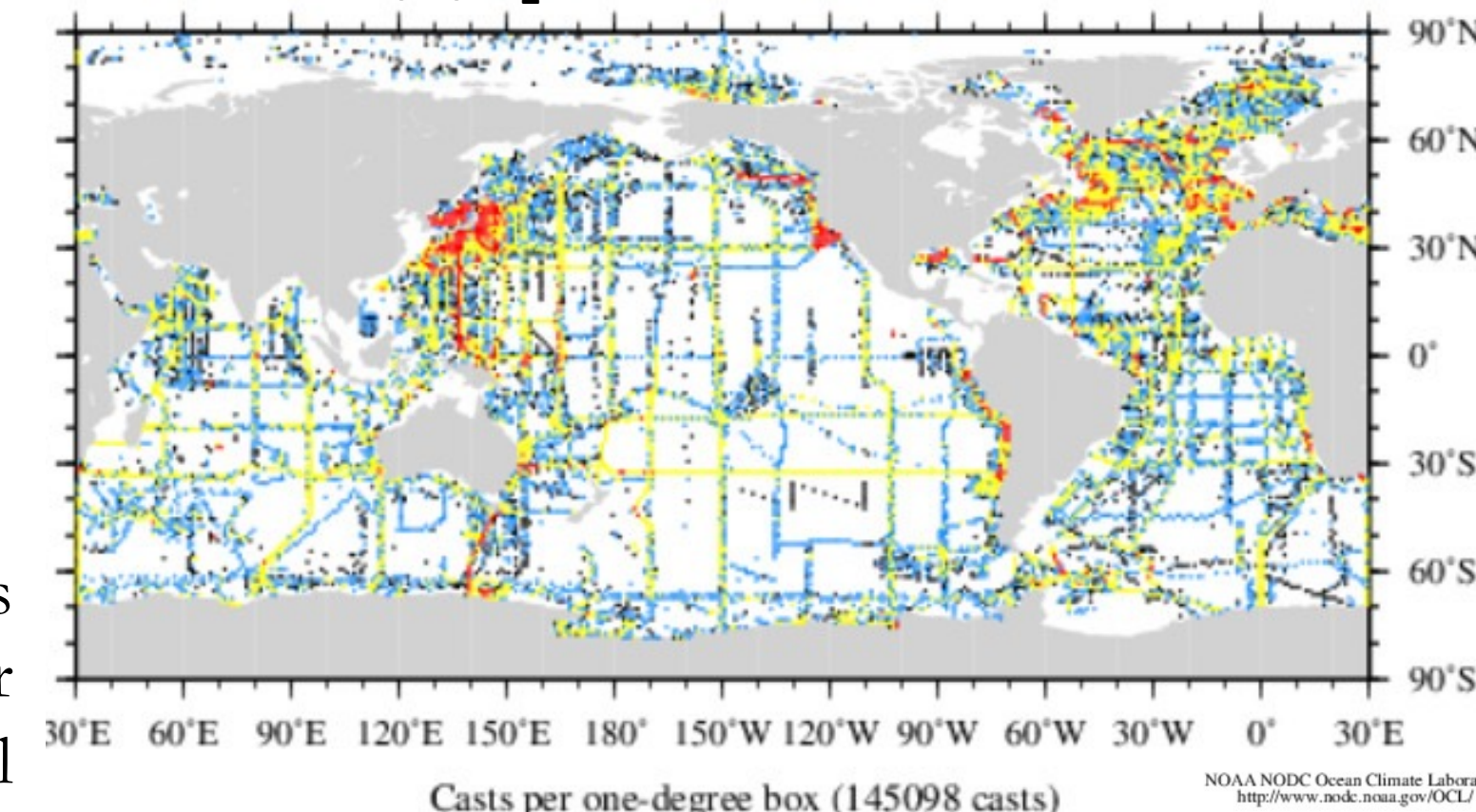
Number of Casts
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Autonomous platforms are better suited than manual measurements for providing evenly distributed data in space and over time.

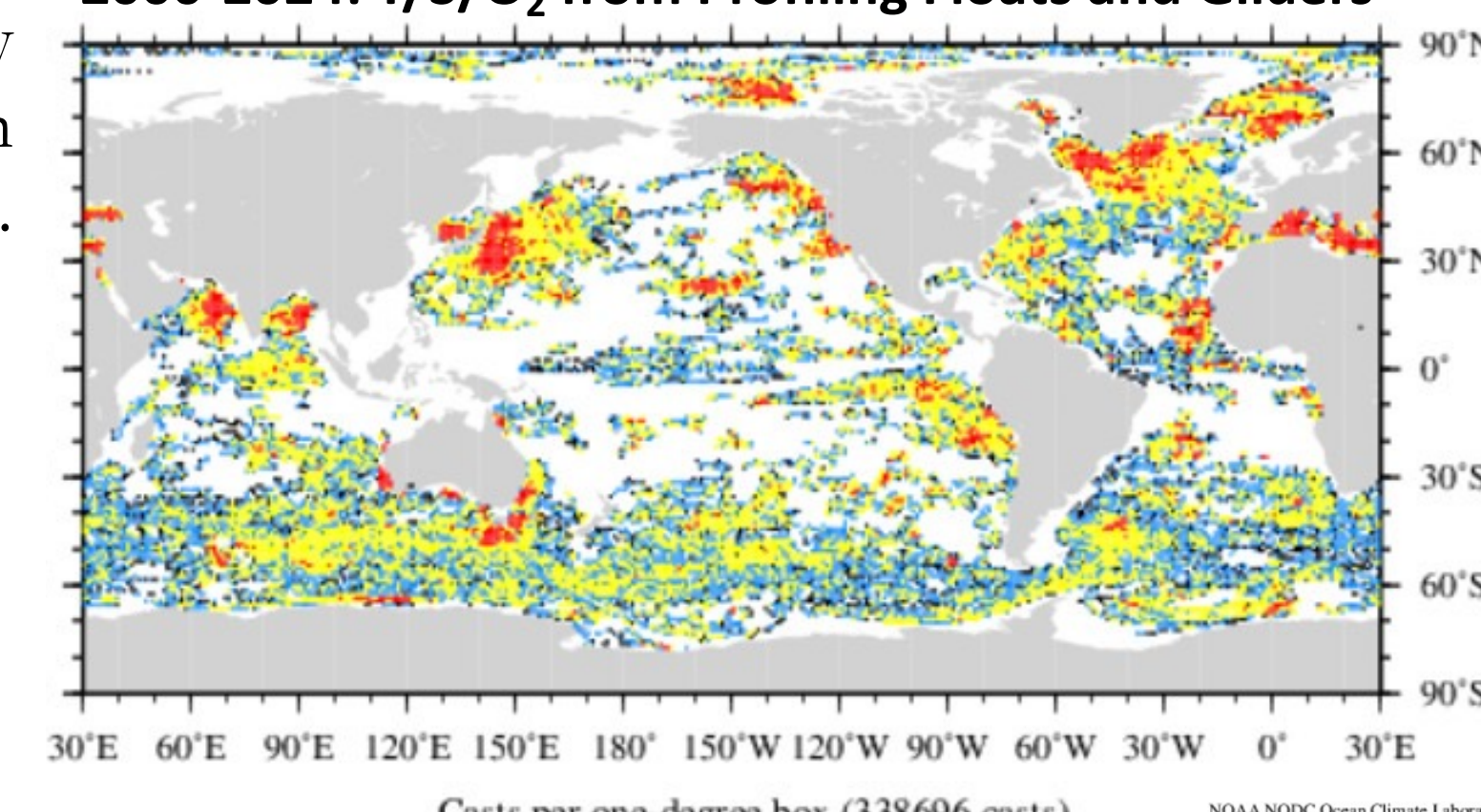


Floats and gliders have become the dominant source of ocean interior data.

1990-2024: T/S/O₂ from Station Data and CTD Casts



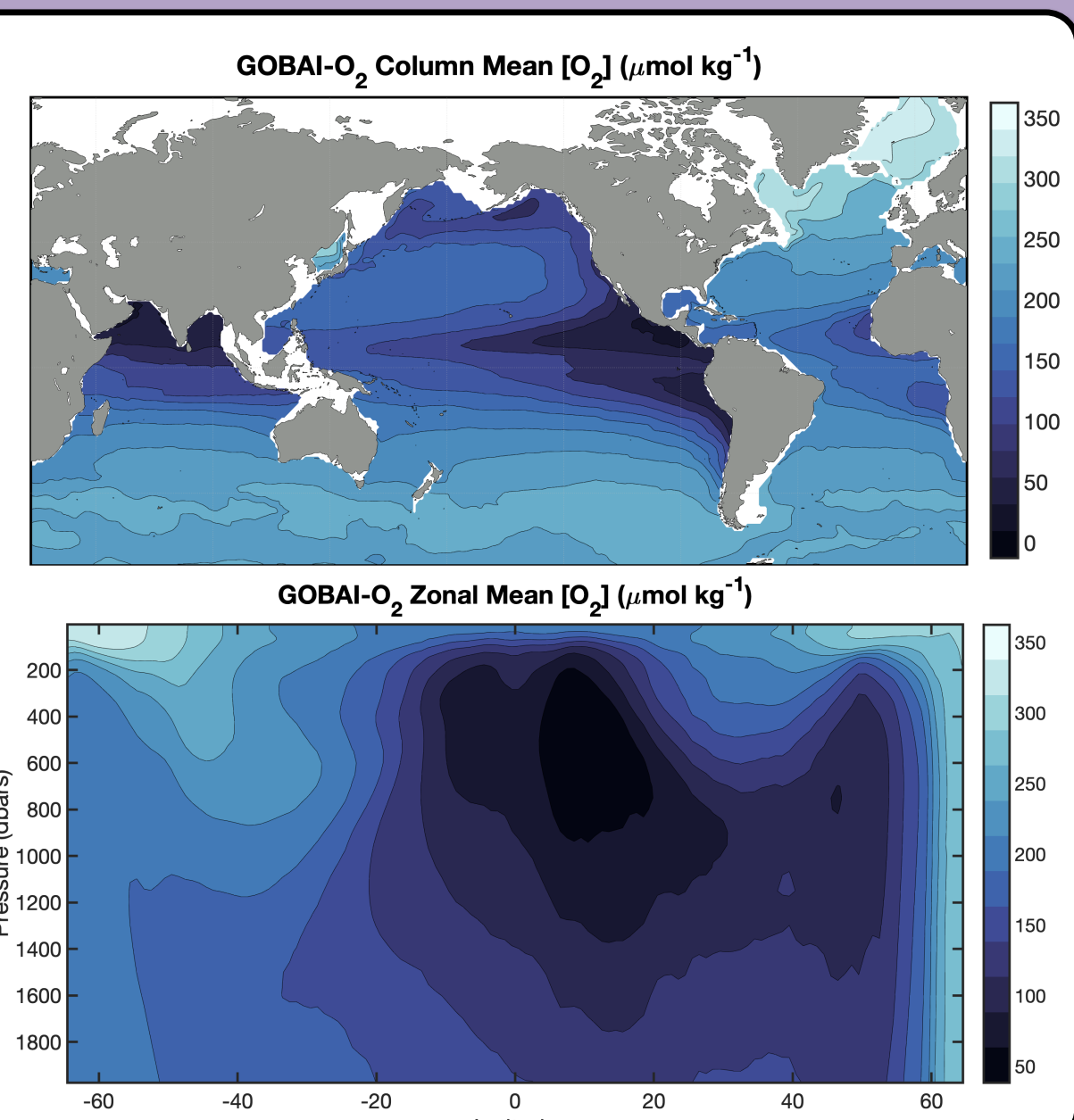
2000-2024: T/S/O₂ from Profiling Floats and Gliders



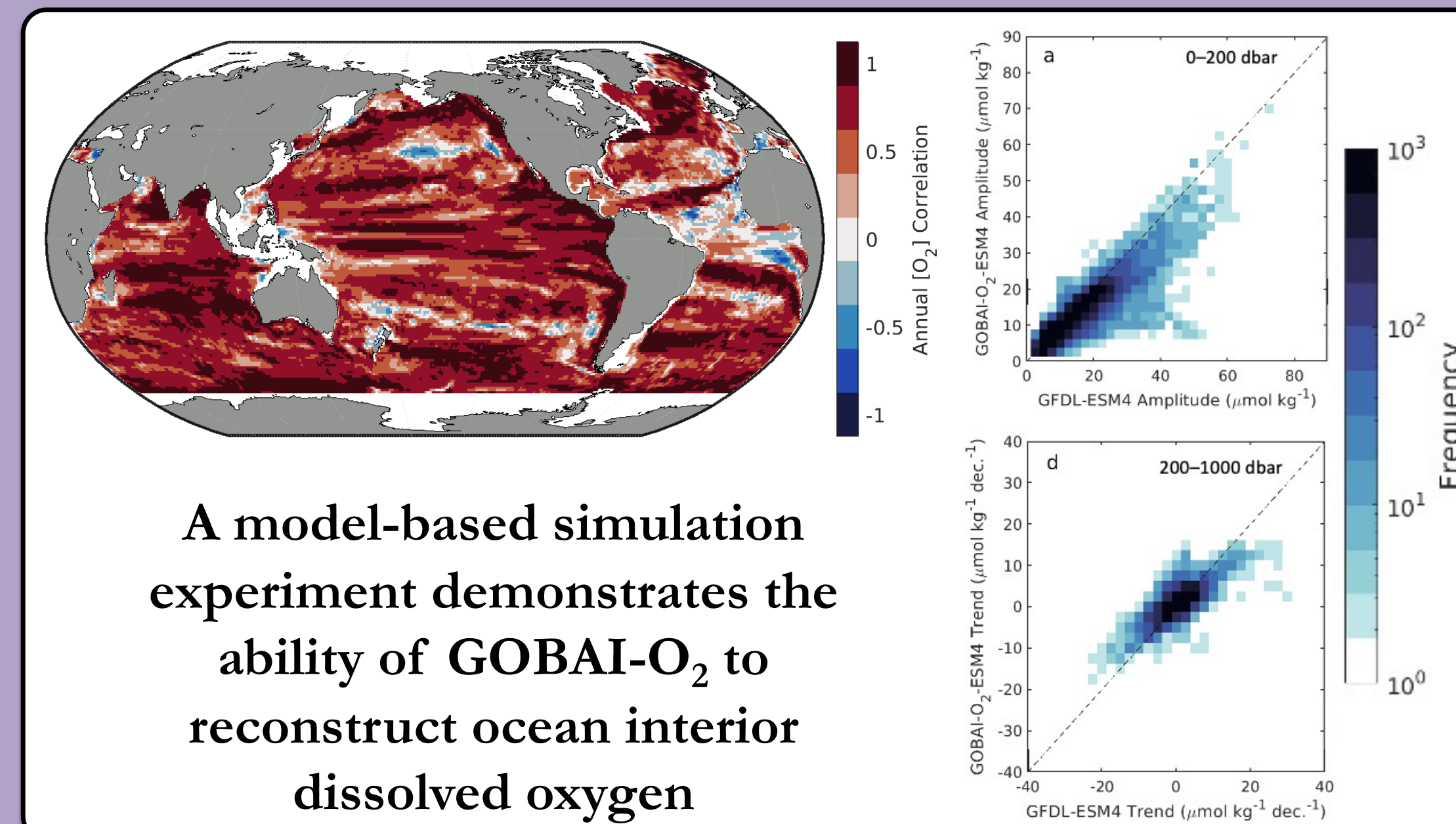
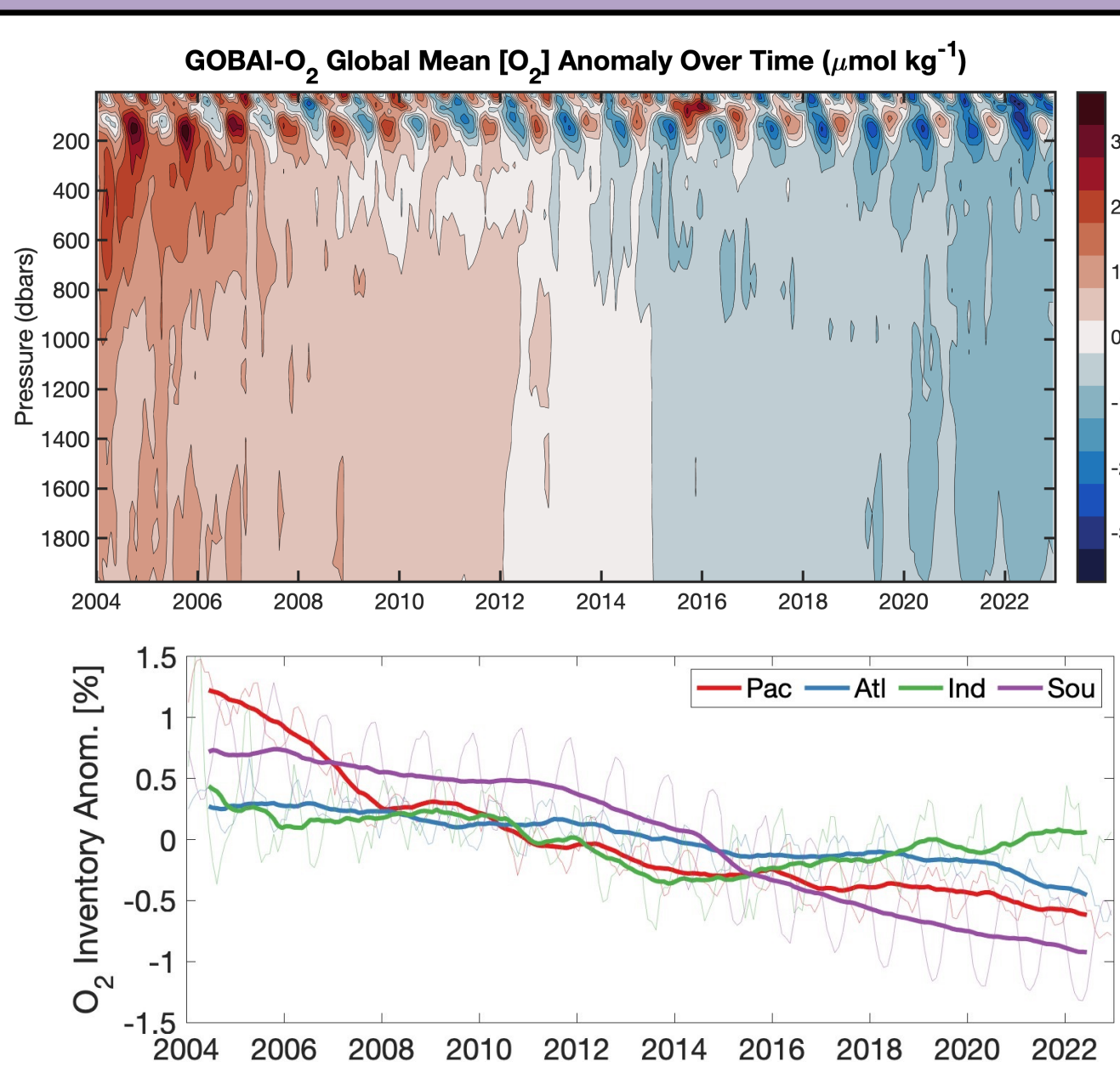
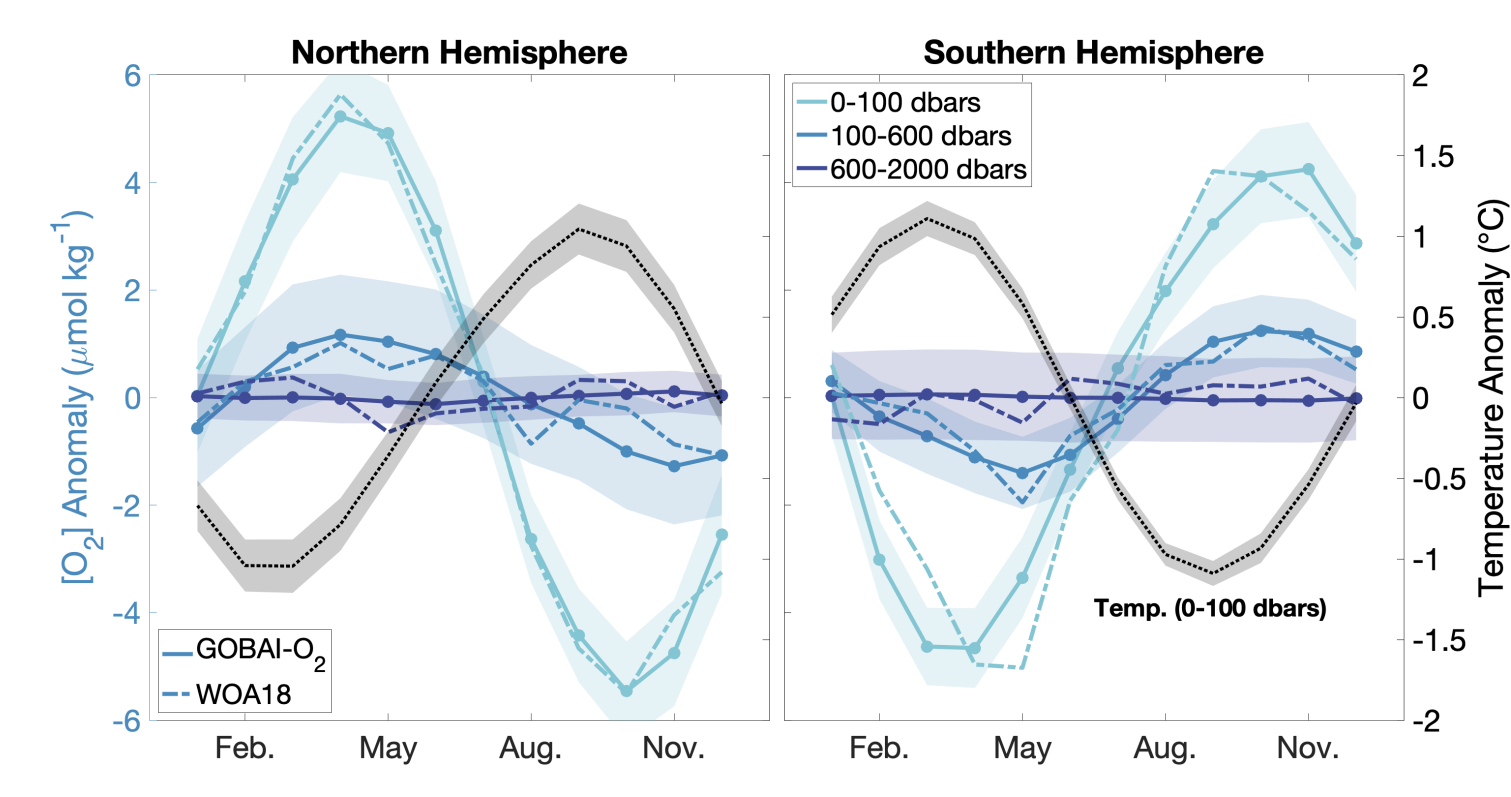
GOBAI-O₂: Gridded Ocean Biogeochemistry from Artificial Intelligence – Oxygen



Example of ocean observations and machine learning used to map marine BGC properties in three-dimensional space and over time



GOBAI-O₂ shows declining oxygen inventories, along with seasonal and interannual variability



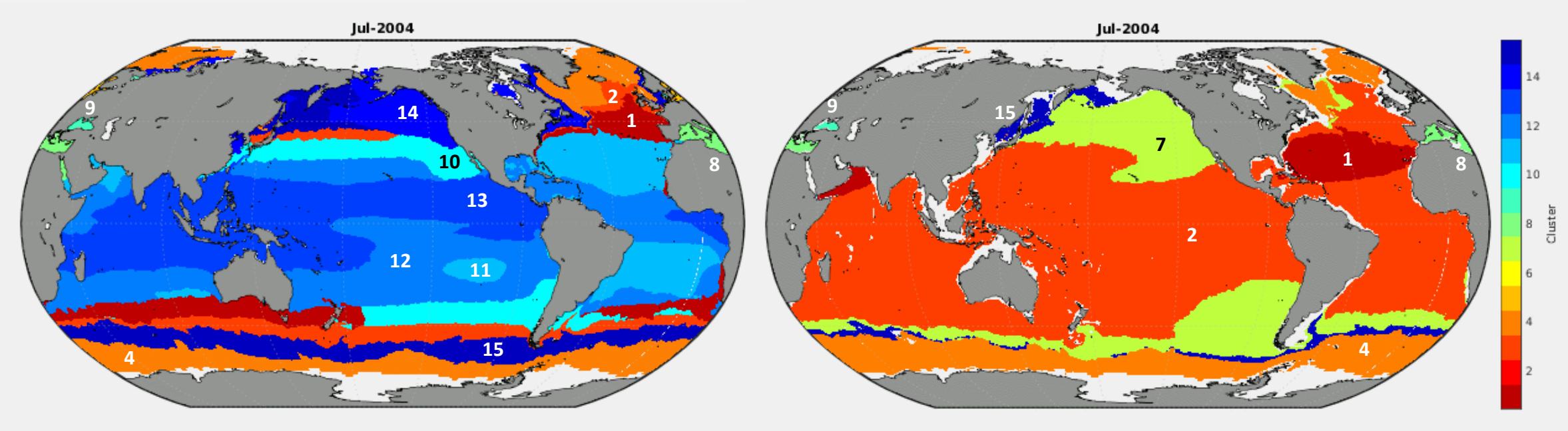
A model-based simulation experiment demonstrates the ability of GOBAI-O₂ to reconstruct ocean interior dissolved oxygen

New Advancements and Strategies for GOBAI Data Products

Additional computing resources have allowed for...

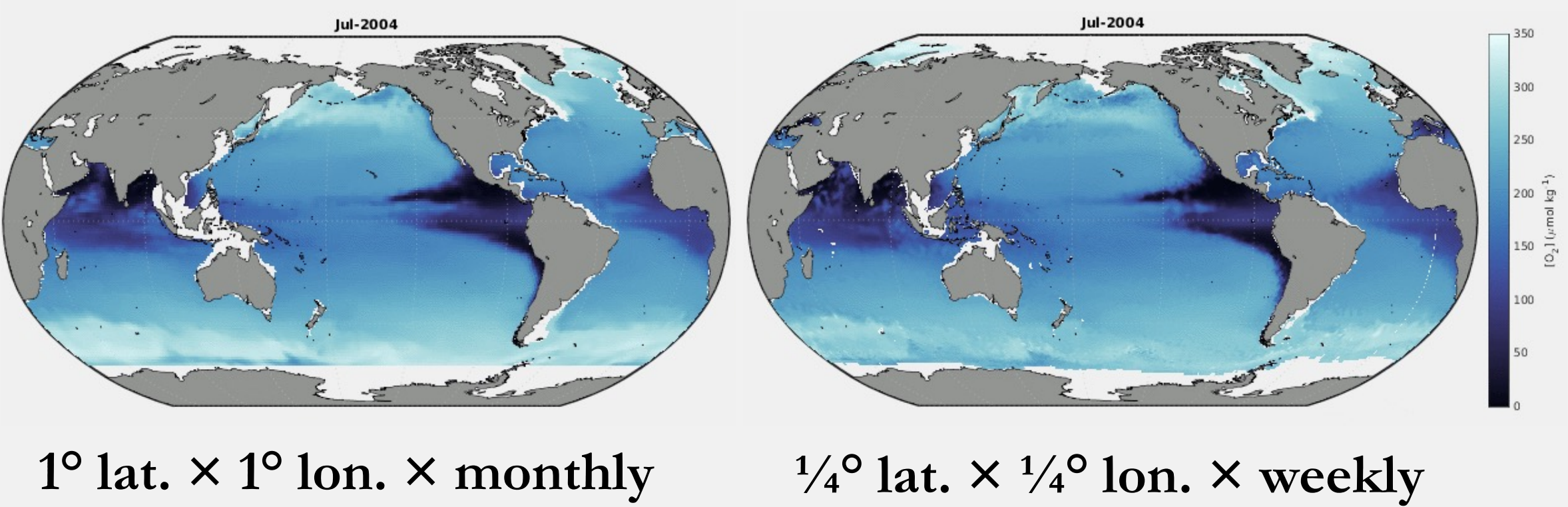
Objective Regional Clustering

Pre-clustering data on the spatial grid reduces some of the burden placed on regression algorithms for capturing biogeochemical variability.



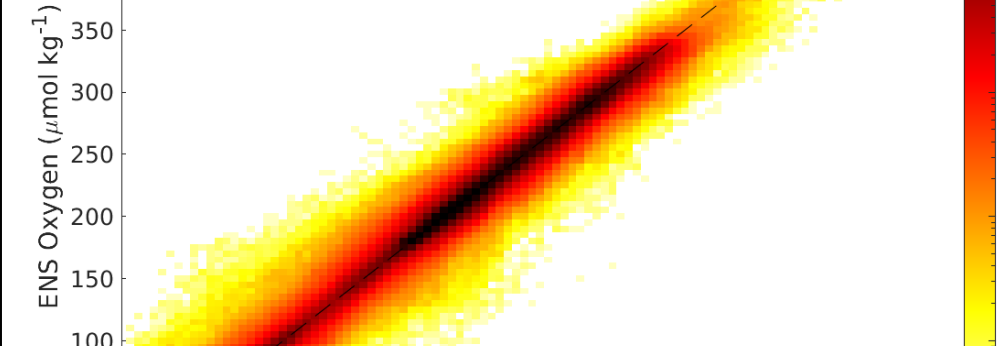
Increased Spatiotemporal Resolution

New data products are being tested to be used as basis for biogeochemical property mapping.

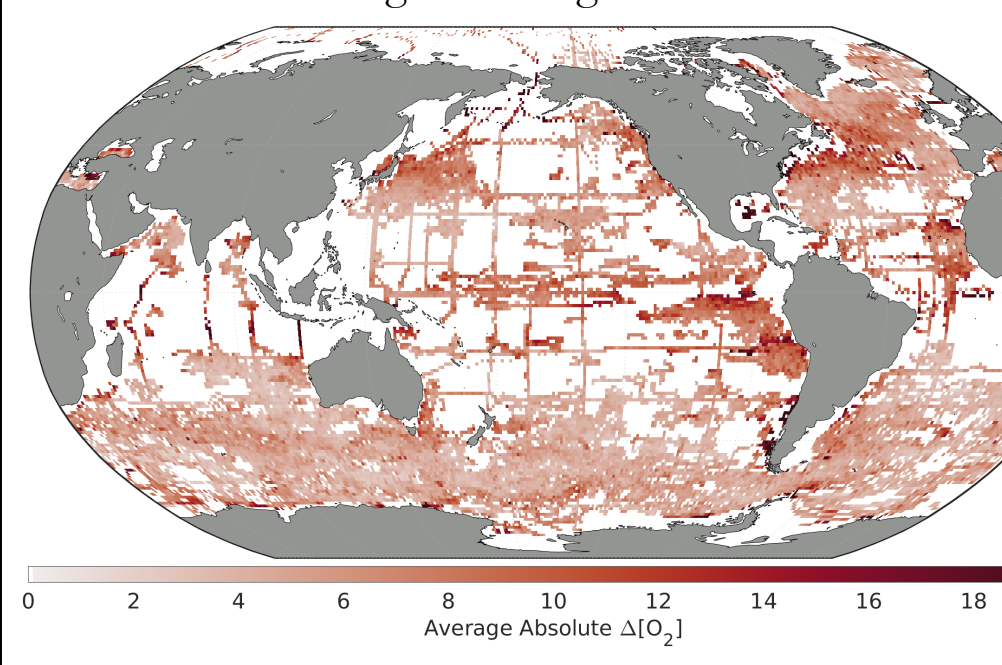


More Comprehensive Evaluation

k-fold evaluation of the algorithm ensemble uses every data point to test different combinations of hyperparameters.



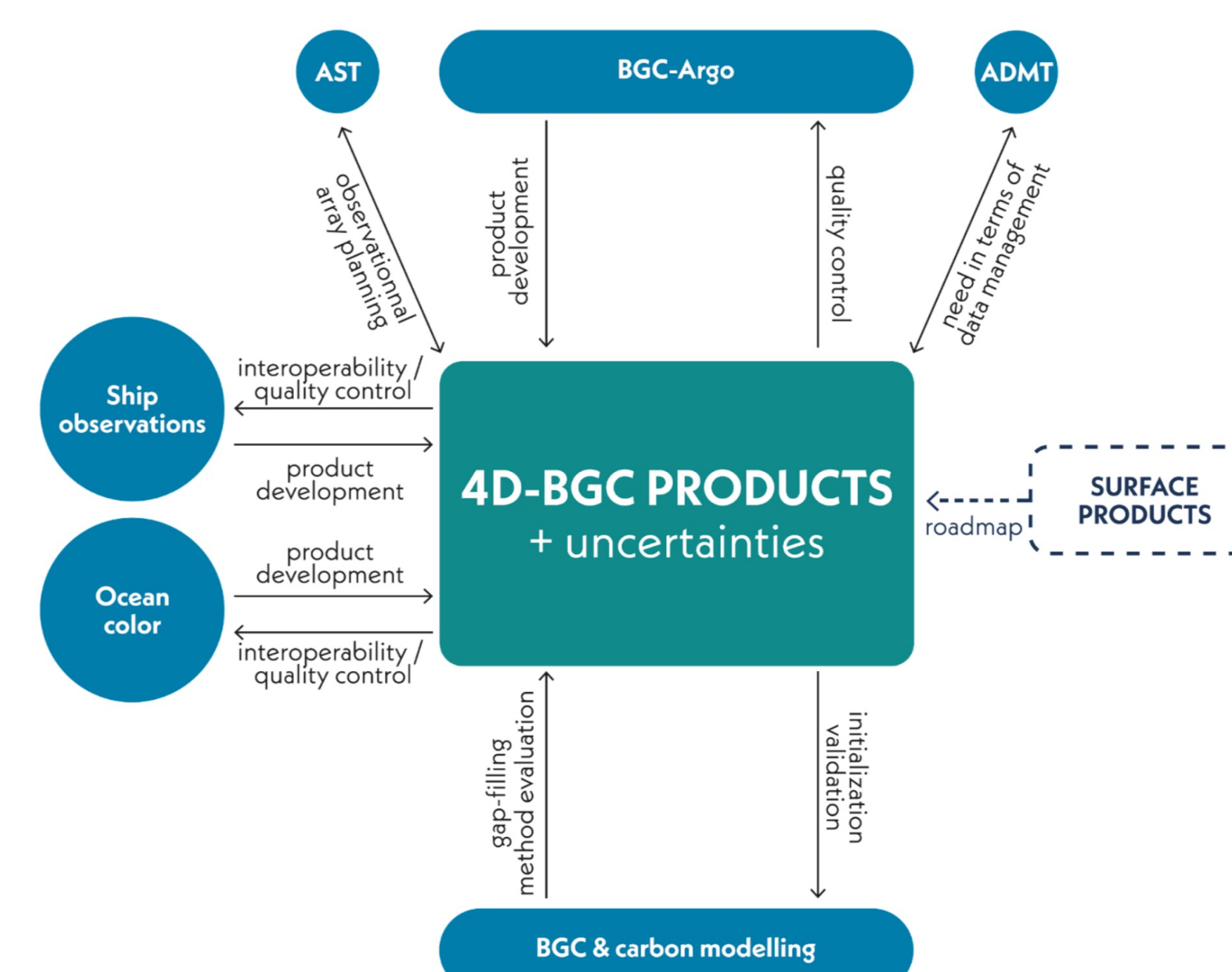
This data-based evaluation allows for spatial context to be given to algorithm uncertainties.



SCOR Working Group #168

Coordinating the Development of Gridded Four-Dimensional Data Products from Biogeochemical-Argo Observations (4D-BGC)

This group will facilitate discussion and coordination among different scientific communities around developing, validating, and distributing 4D-BGC products from observational datasets, with a focus on the BGC-Argo array.



Terms of Reference

- Establish connections among 4D-BGC product developers, observational communities and data synthesis efforts, and end-user communities.
- Compile an inventory of 4D-BGC products that highlights the original data and methodology used to create each one, provides data access information, and suggests relevant applications.
- Synthesize available estimates of global to regional magnitudes, variabilities, and trends of key biogeochemical processes that can be refined by 4D-BGC products, and identify actions that can be taken to achieve those refined quantifications.
- Develop recommendations for methods to create, distribute, and dynamically update 4D-BGC products, as well as strategies to estimate uncertainties from grid-cell to global scales.
- Build capacity within the oceanographic community, especially among early career researchers and within underrepresented groups, to ensure 4D-BGC product development and usage is sustained and supported.