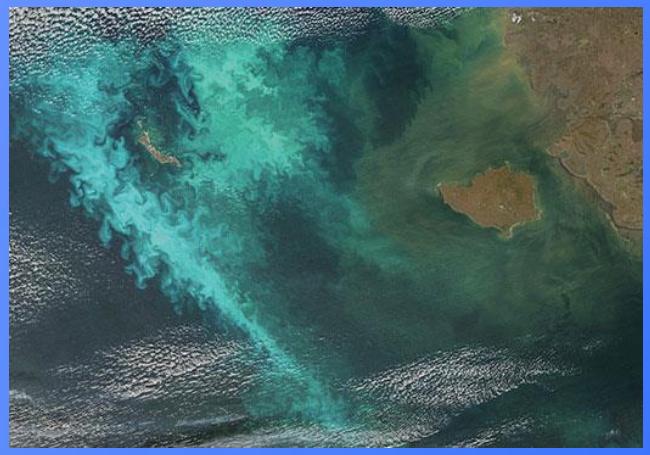
Ocean aspects of the GCOS Implementation Plan 2016:

Connection to Climate Information and Services for Adaptation, Mitigation and the SDGs

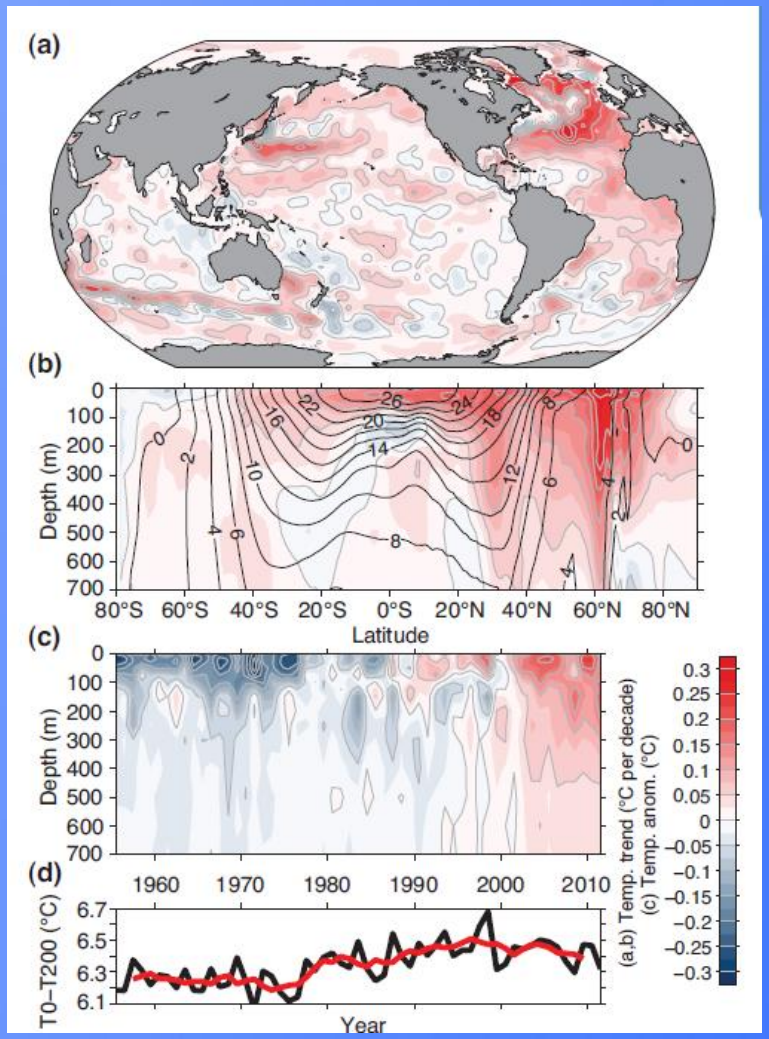


Toste Tanhua

GEOMAR Helmholtz Center for Ocean Research Kiel

UNESCO-IOC

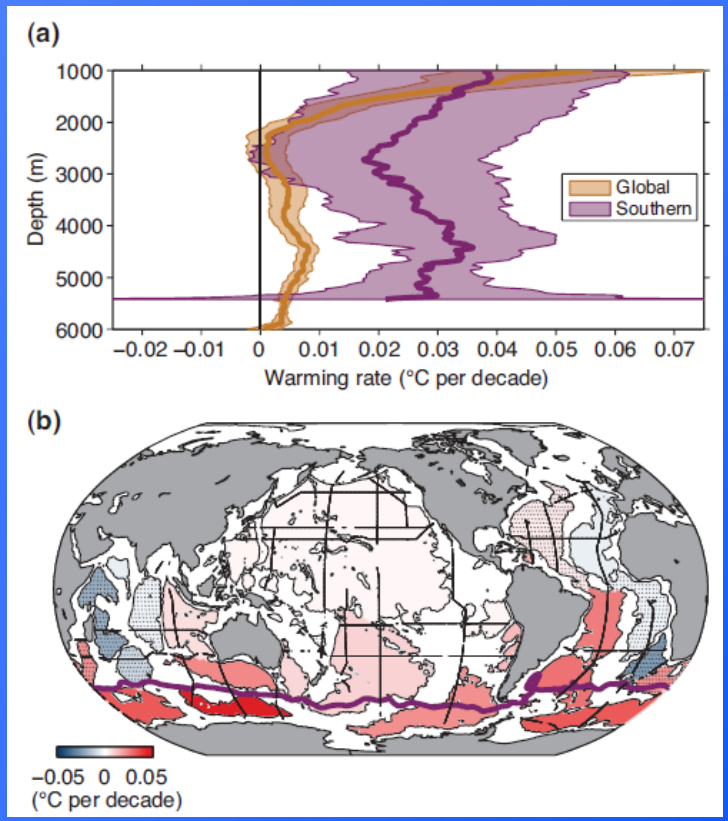
The Ocean is warming



The warming rate is approximately

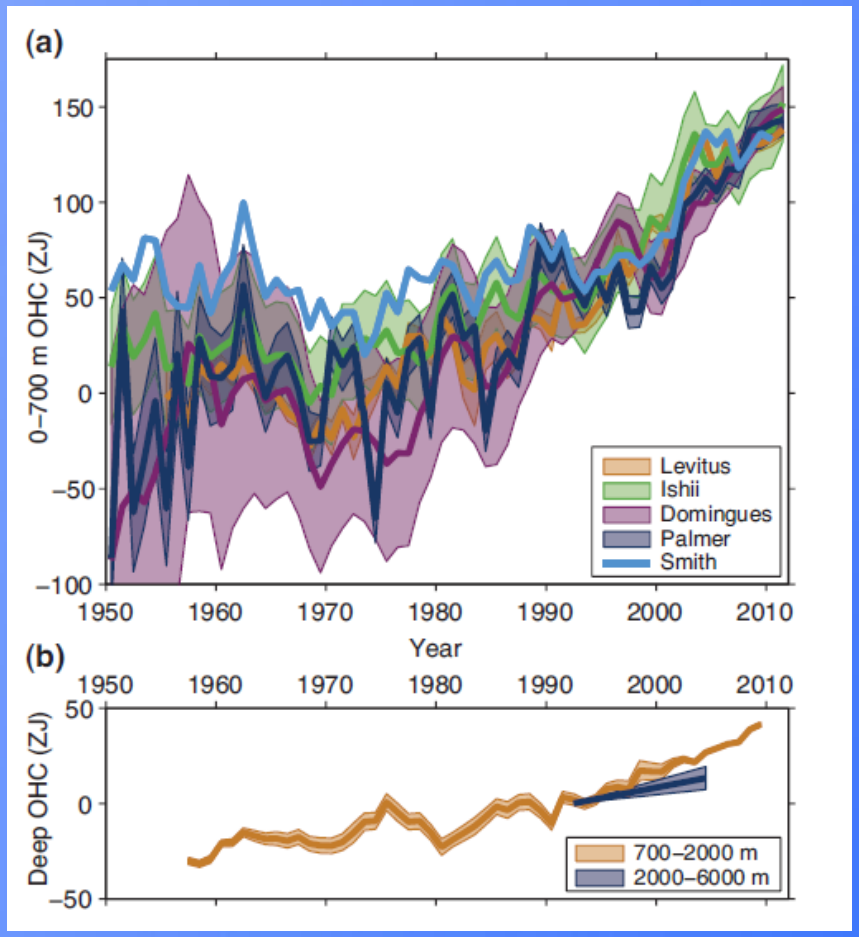
- 0.11 C/decade the upper 75 m
- 0.015 C/decade at 700m

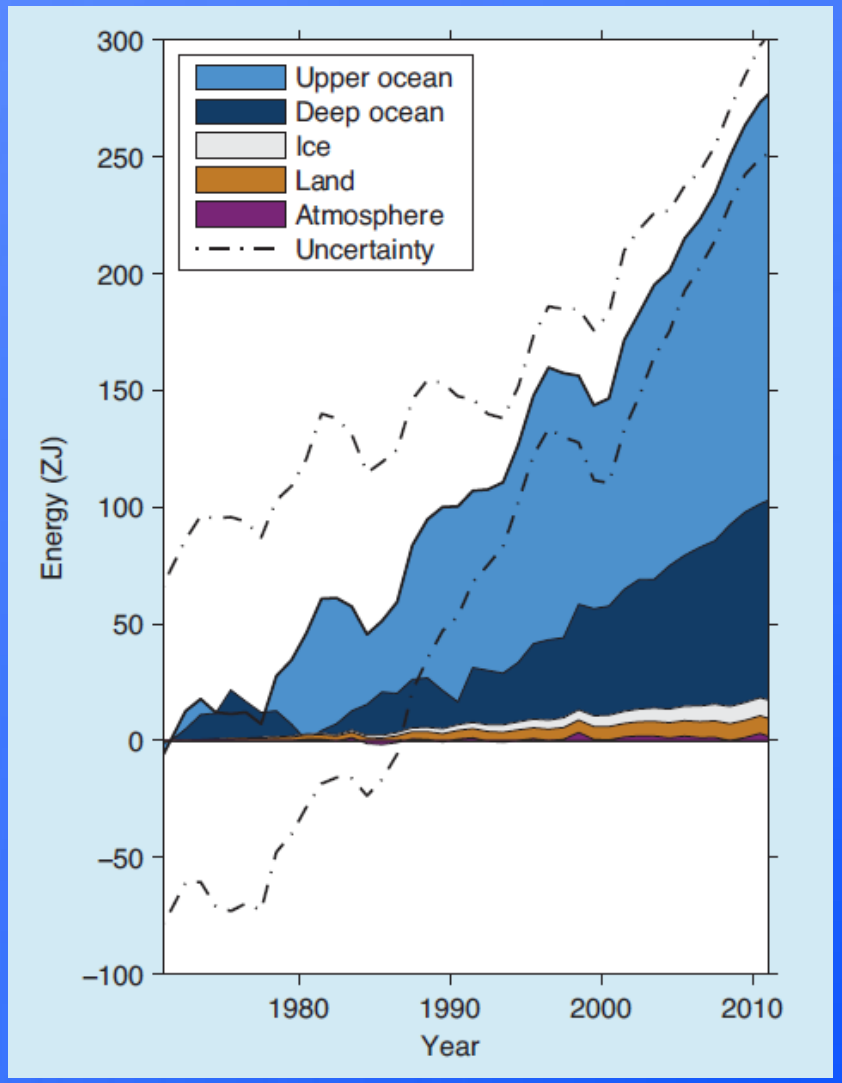
This increased ocean stratification by ~4%



IPCC AR5

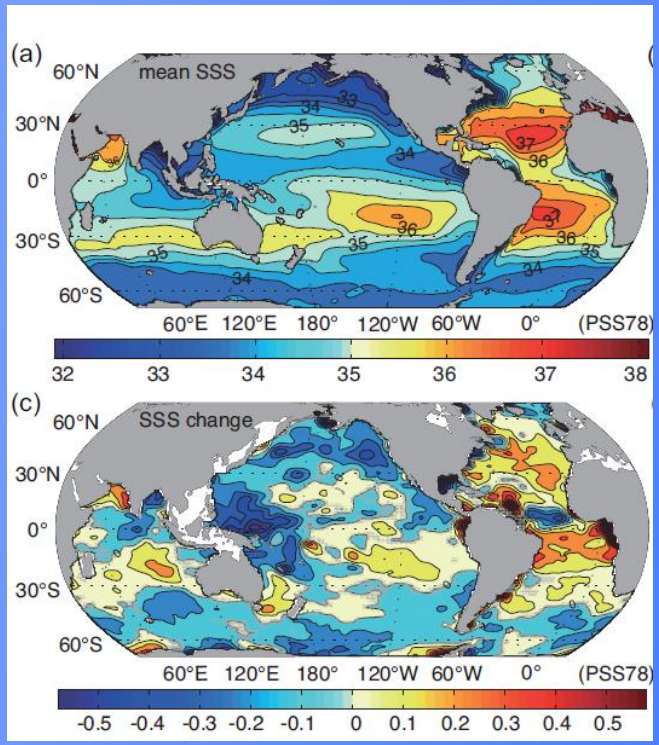
The Ocean store ~93% of excess heat

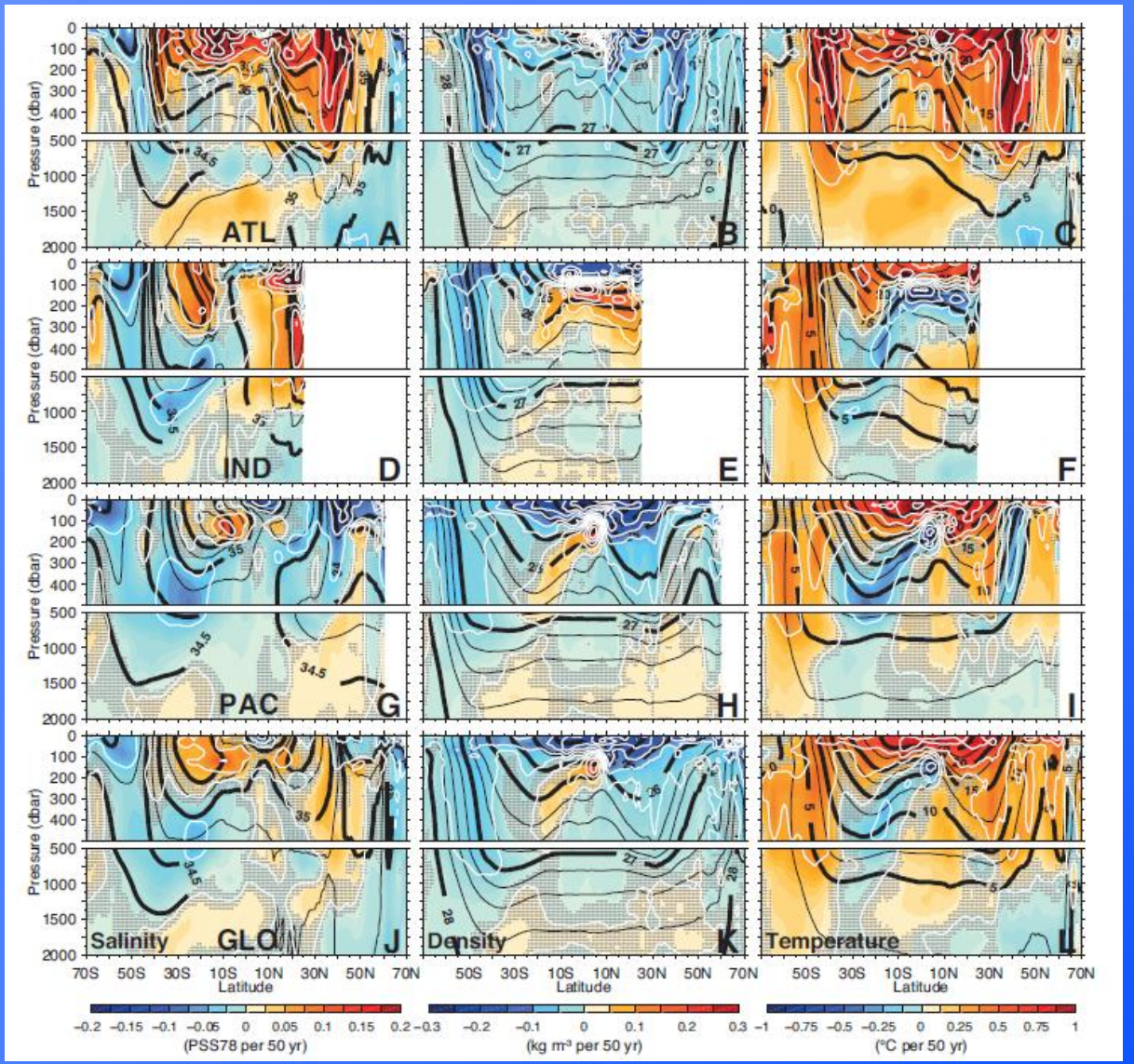




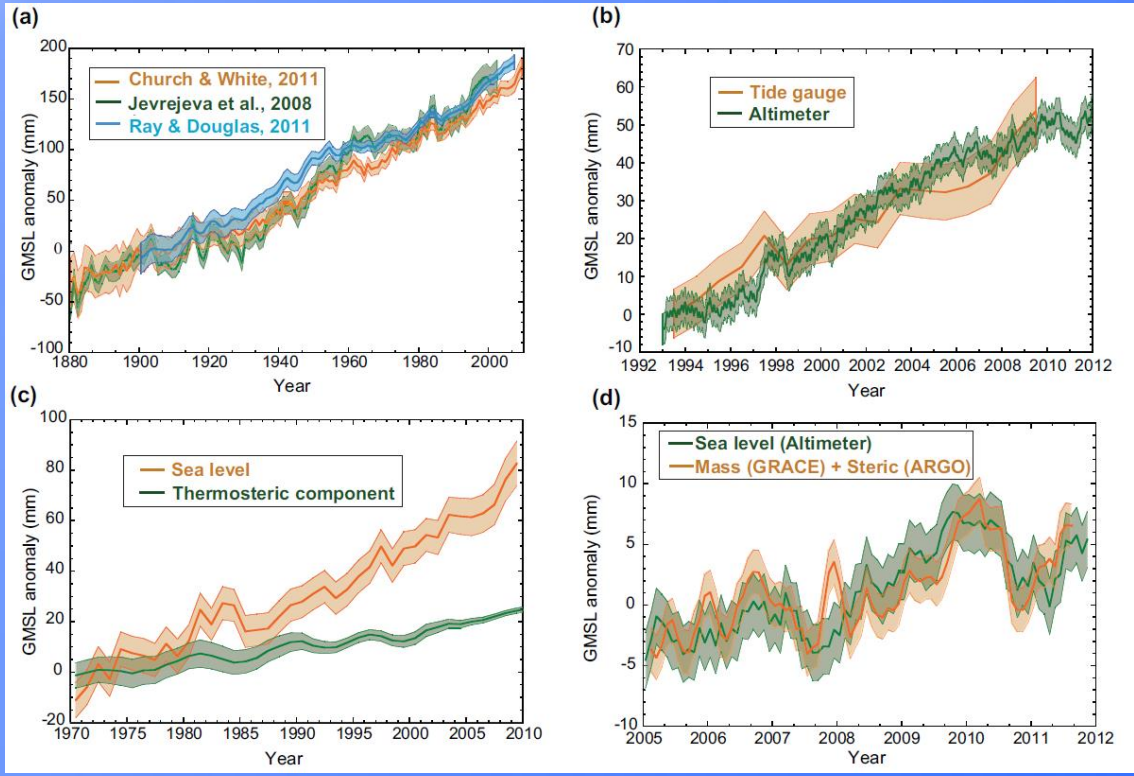
The distribution of salinity (Evaporation / Precipitation) in the ocean is changing

Changes in sea surface temperature and salinity (density) are propagated to the ocean interior.



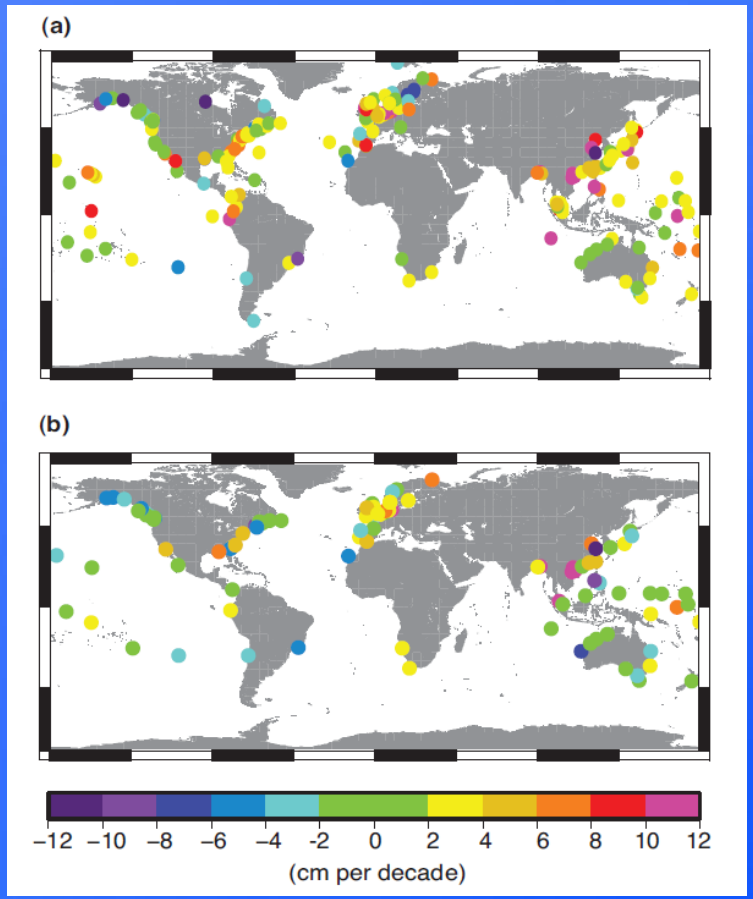


The sea-level is rising

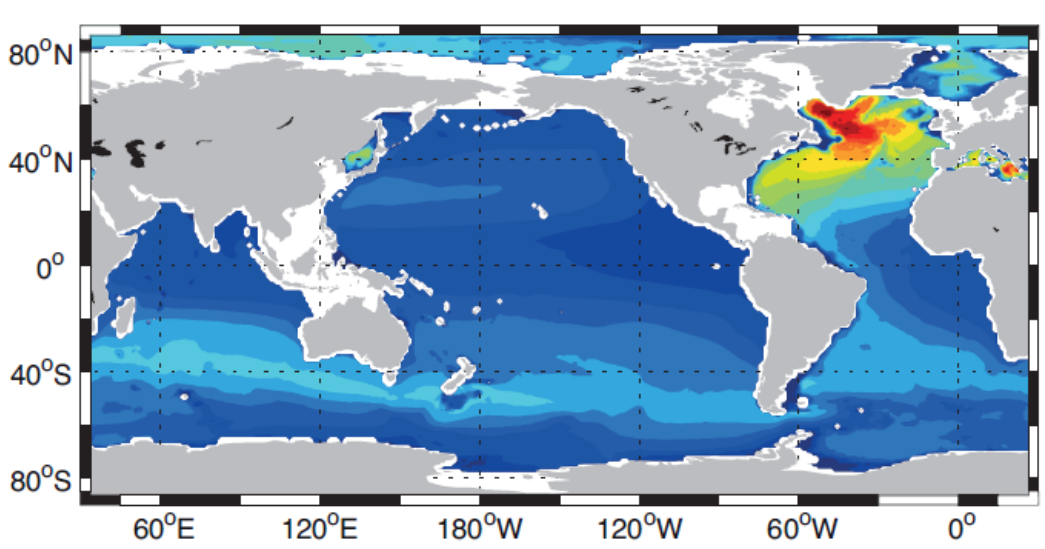


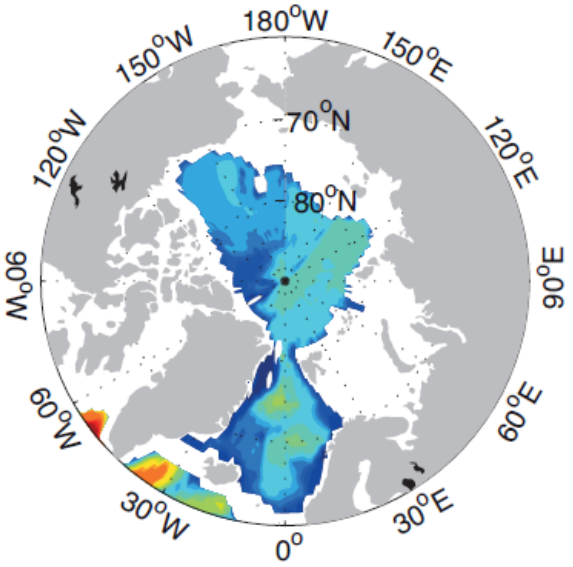
Various observing systems provide coherent Global Mean Sea Level rise, increasing the confidence.

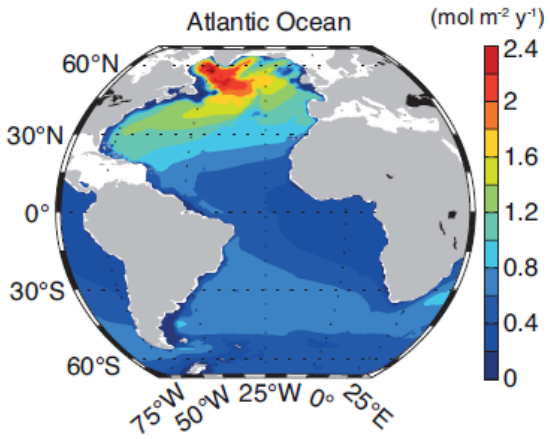
There are significant regional differences in sea level trends.

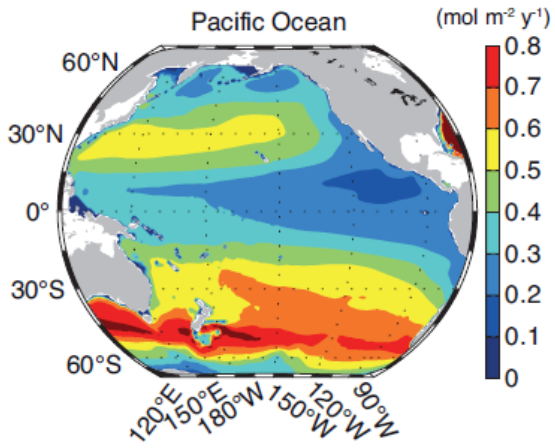


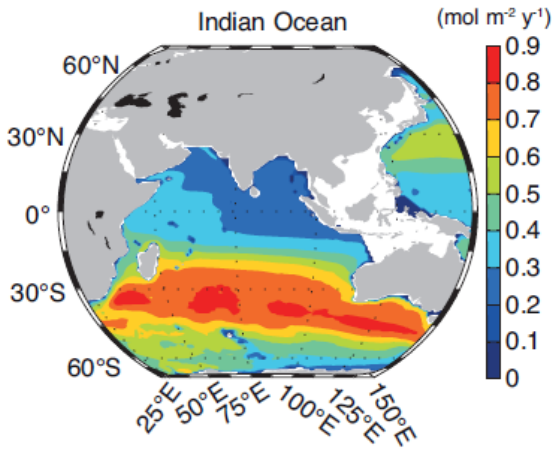
The Ocean stores ~30% of Anthropogenic CO_2



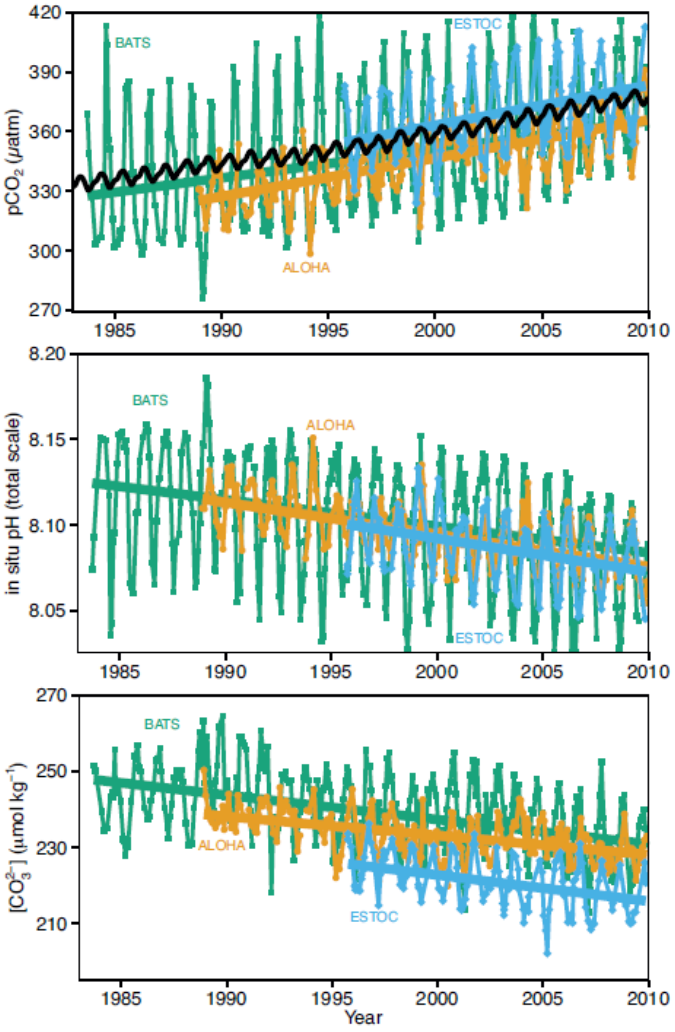


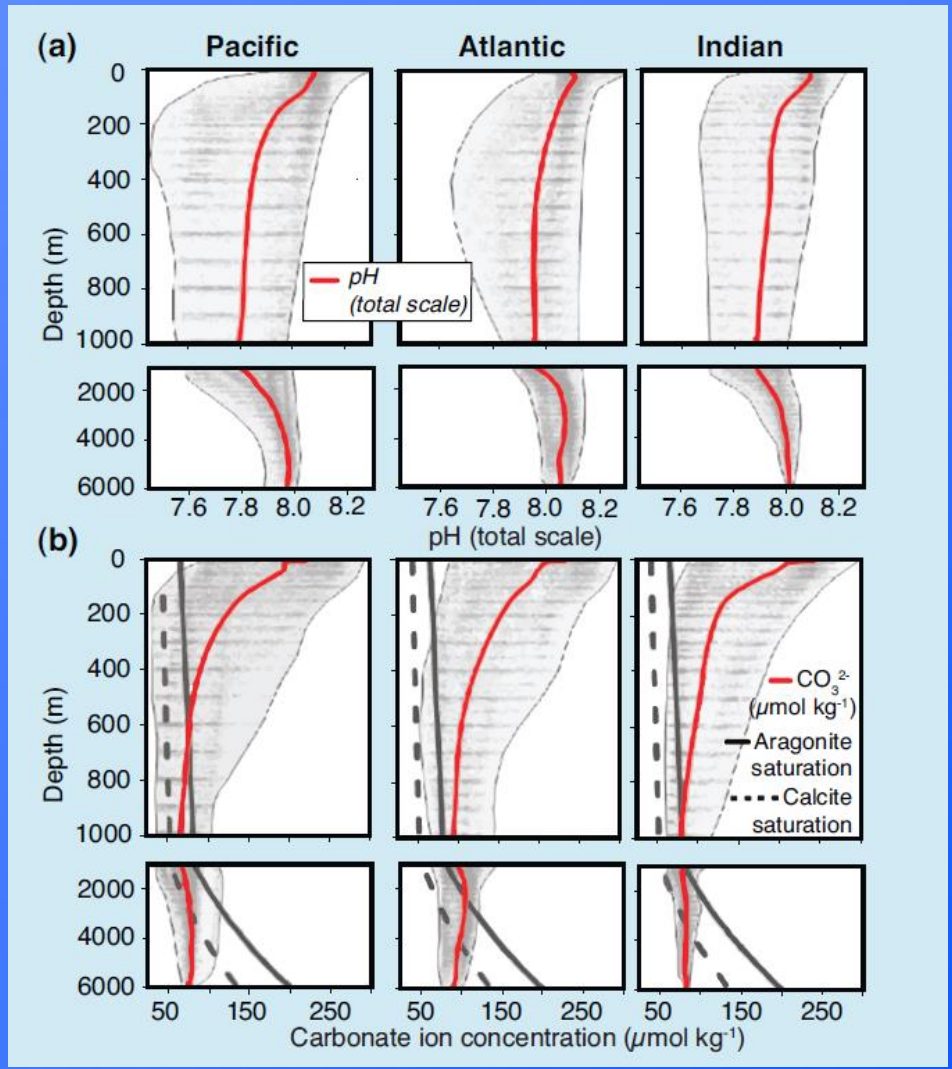




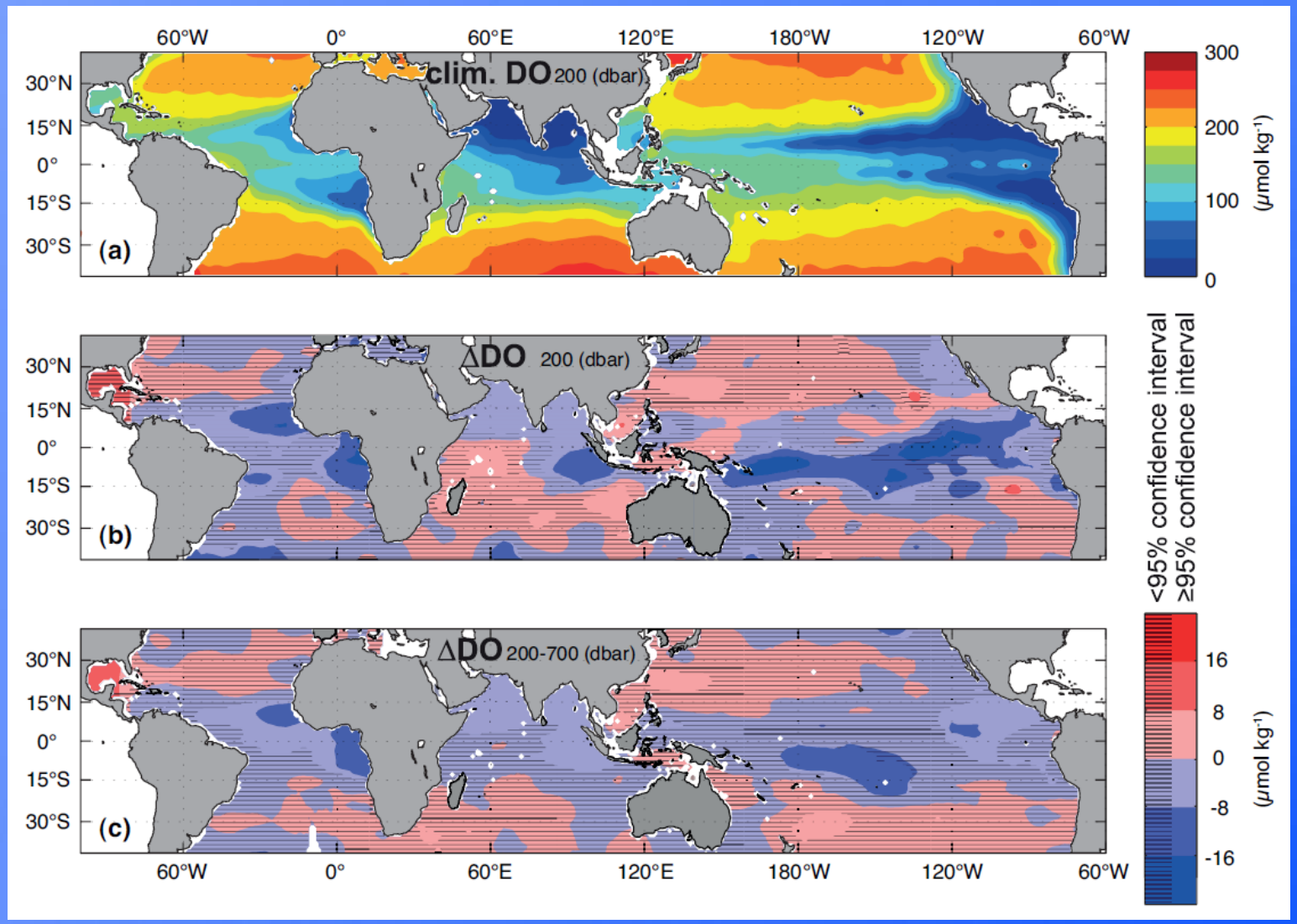


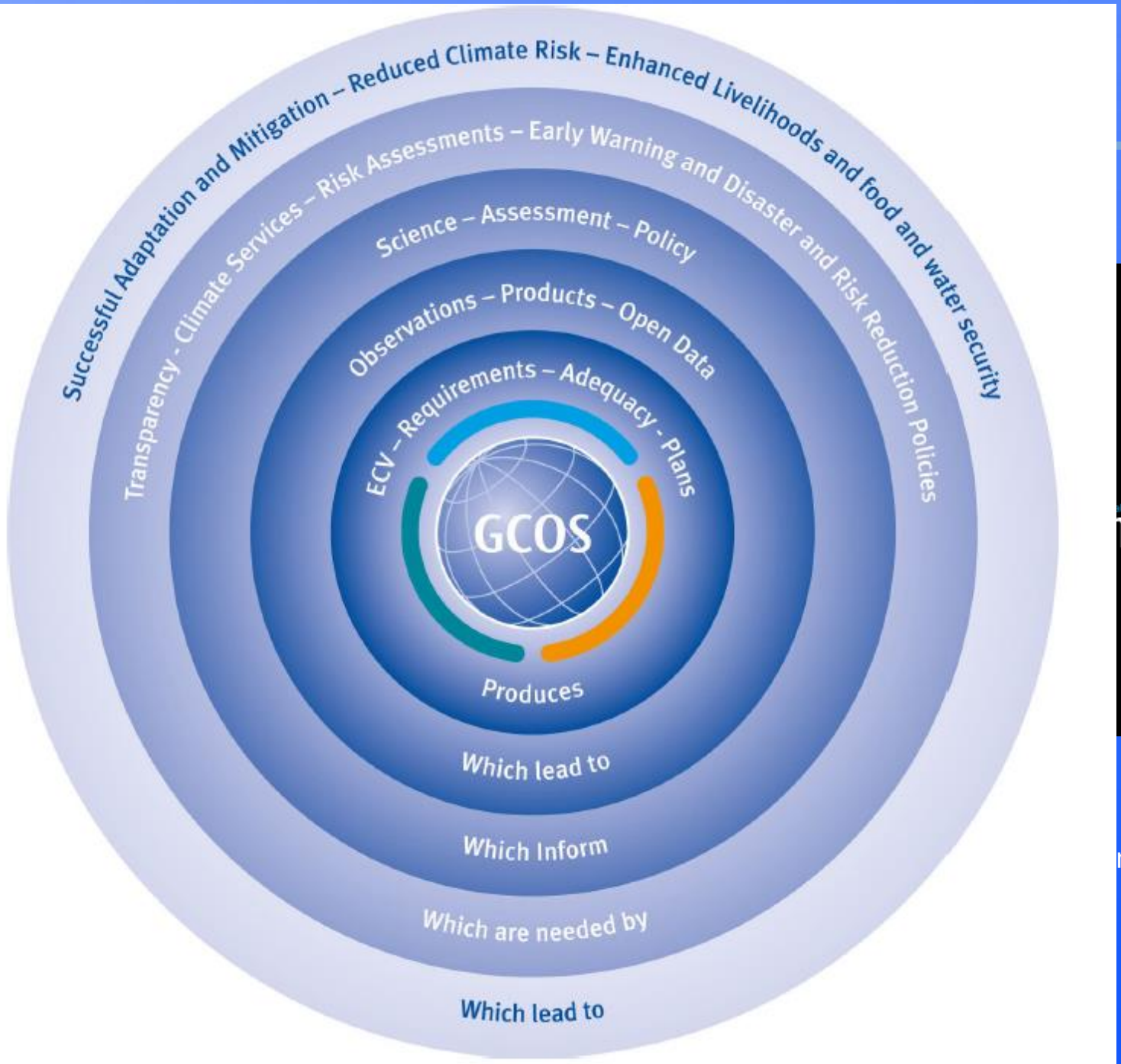
Ocean storage of Anthropogenic CO_2 leads to decreasing pH, $[CO_3^{2-}]$ and calcium carbonate saturation levels





Changes in circulation and stratification leads to changes in interior ocean oxygen conc.





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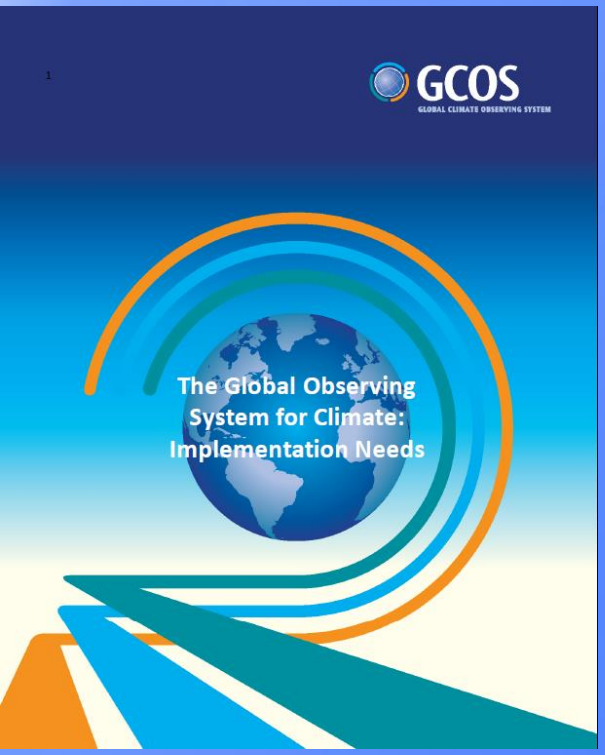
Ocean Climate Observations through Essential Climate Variables (ECVs)



Physics:

Temperature, Sea Surface Temperature, Salinity, Sea Surface Salinity, Currents, Surface Currents, Sea Level, Sea State, Sea Ice, Ocean Surface Stress, Ocean Surface Heat Flux

Biogeochemistry:

Inorganic Carbon, Oxygen, Inorganic Nutrients, Transient Tracers, Nitrous Oxide, Ocean Colour

Biology / Ecosystems:

Plankton, Marine Habitat Properties

"Attaining and sustaining global coverage is the most significant challenge of the oceanic climate observing system."

The challenge of sustained ocean observations can only be met through national commitments to the global implementation and maintenance effort and with international coordination.

The Global Ocean Observing System – a multitude of Platforms and Networks

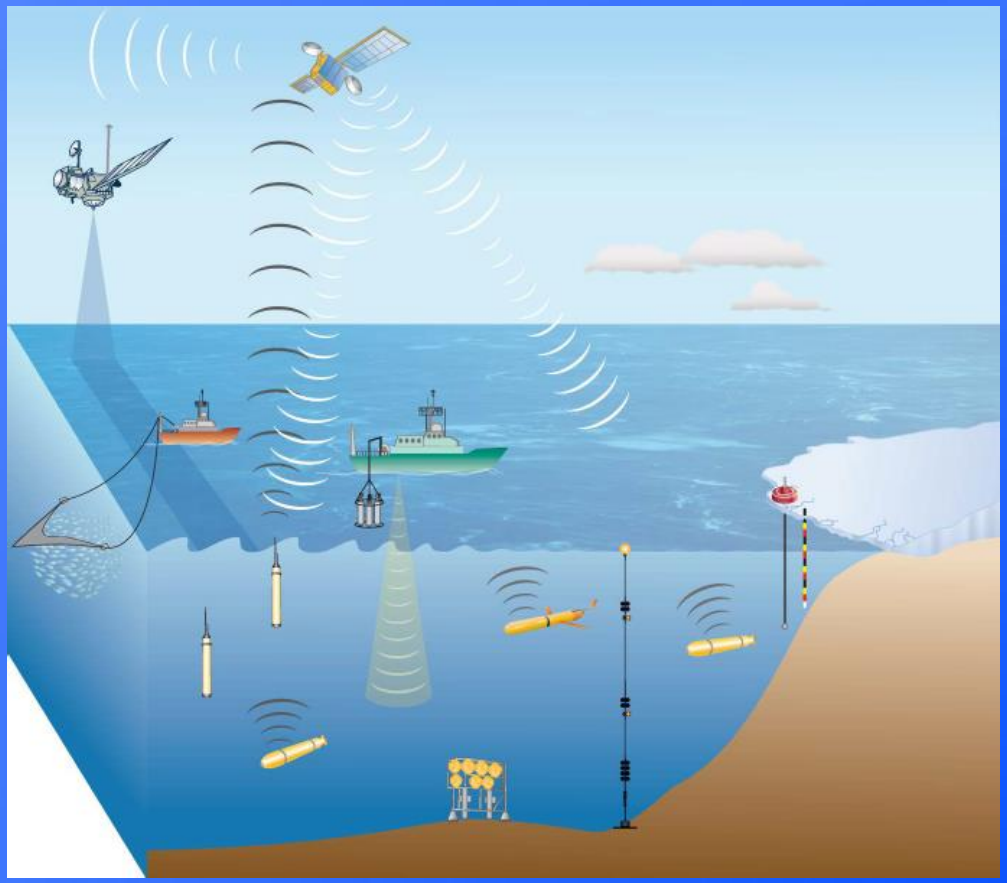
The Global Ocean Observing System is organized by user-driven requirements for :

- Monitoring the climate system;
- Detecting and attributing climate change;
- Assessing impacts of, and supporting adaptation to, climate variability and change;
- Application to national economic development;
- Research to improve understanding, modelling and prediction of the climate system.

- To meet the ECV requirement and to provide the greatest resilience of the observing system, the ocean observing system is coordinated through global networks which are organized around a particular platform or observing approach and with defined missions and implementation targets.
- The composite observing networks monitor ocean ECVs globally, but do this at different temporal and spatial scales depending on requirements and feasibility.

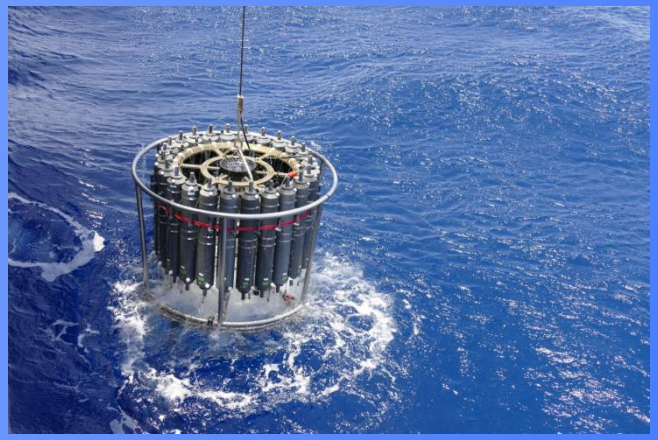
Requirements of the Global Ocean Observing System for Climate

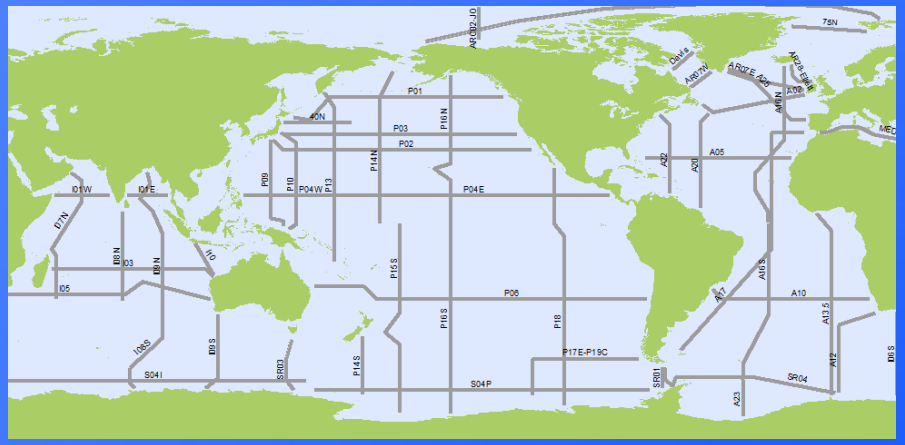
- There is a pressing need to expand the monitoring capabilities by obtaining global coverage using proven technologies and to continue to develop novel observing technologies, to establish communications and data management infrastructure, and to enhance ocean analysis and reanalysis capacity.
- The composite global ocean observing system makes best use of a mix of proven satellite and in situ technologies and optimizes the contributions from existing observing assets and deployment opportunities for both global surface and subsurface variables.
- There is a need to assess existing international, national and regional plans that address the needs to monitor and predict the coastal regions and develop plans were they do not exist.
- The Global Data Assembly Centres (GDACs) are the logical place to focus the development of integrated ECV data access and by using multiple GDACs the data content can be mirrored between Centres and accessed through either one, providing redundancy and resilience in the data management structure.



Sustained funding for sustained observations

- **Much of the investment and management of the in situ observing activities continue to be carried out under research agency support and on research program time limits.**
- A particular concern is the fragility of the financial arrangements that support most of the present in situ effort; there has been very limited progress in the establishment of national ocean or climate institutions tasked with sustaining a climate-quality ocean observing system.
- Satellite observation activities however are organized across satellite agencies and are focused around ECV based constellations and hence activities are well aligned with GCOS requirements. Clearly those need to continue.

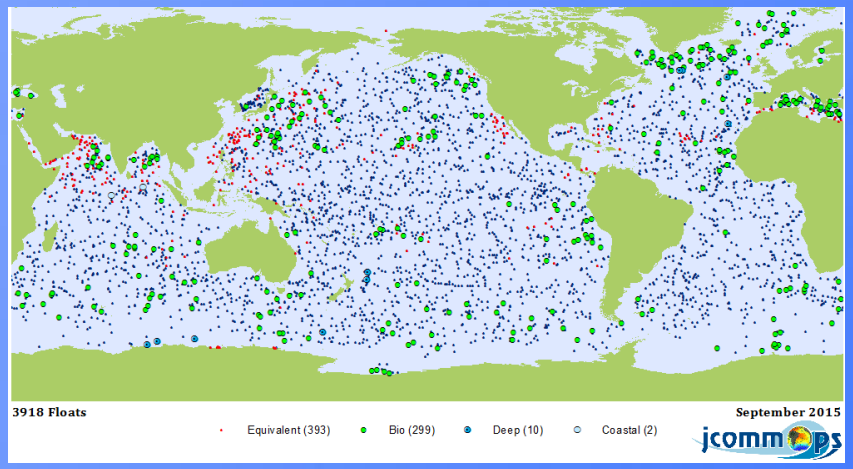




The Global Repeat Hydrography Program (GO-SHIP) is an essential component of the Ocean Observing System providing reference quality data and full depth coverage, but with mainly research driven funding.

New and improved technologies opens new opportunities

The regular reporting by Parties on systematic observation to the UNFCCC, which includes national institutional arrangements and ocean observation activities, should be encouraged and utilized to assess progress in national action.

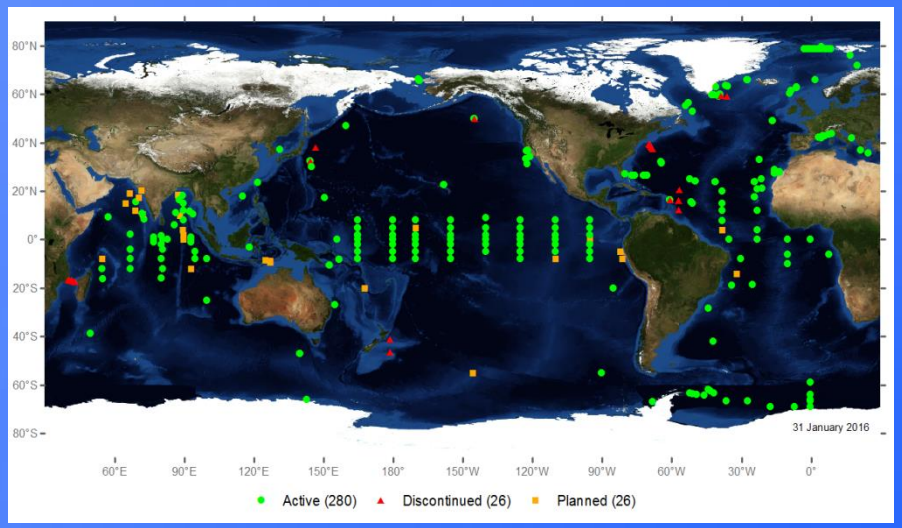


- Profiling autonomous floats (Argo) is a key element of the Ocean Observing System.
- New technologies opens possibility for additional (biogeochemical) variables and deeper observations.

- New or improved ocean-observing satellite and in situ sensors and platforms, coupled with advances in telecommunications, are continuously becoming available for improving the sustained ocean climate observation system.
- Satellites continually move towards becoming higher resolution in space and time, with constellation based planning enabling diurnal temporal resolution.
- During the last decade, the use of autonomous in situ platforms has revolutionized the ocean observing system, and the fast technological advance on platforms and sensors (primarily biogeochemical sensors) will continue to improve the system.

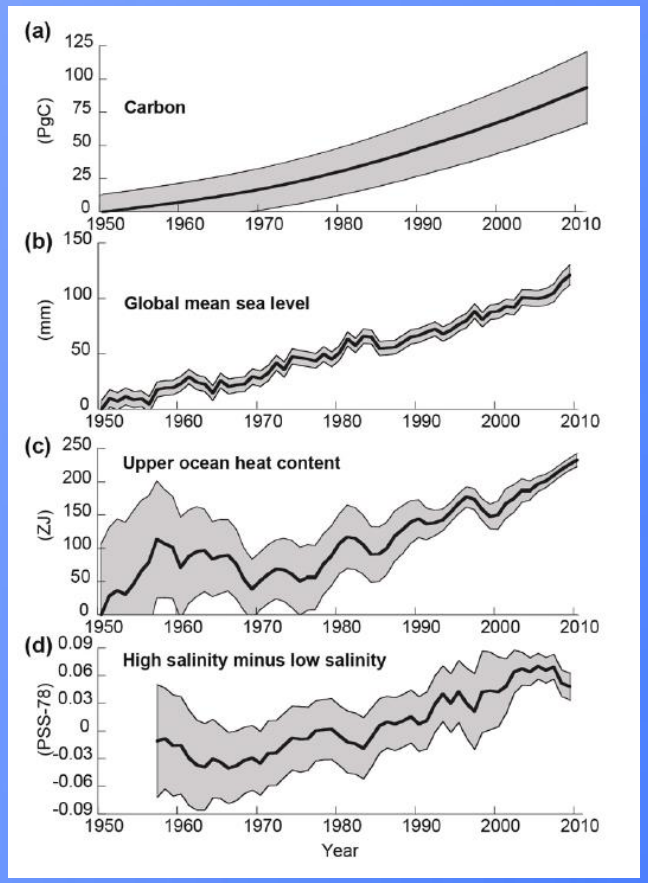
Ocean Observations involves a large range of temporal and spatial scales

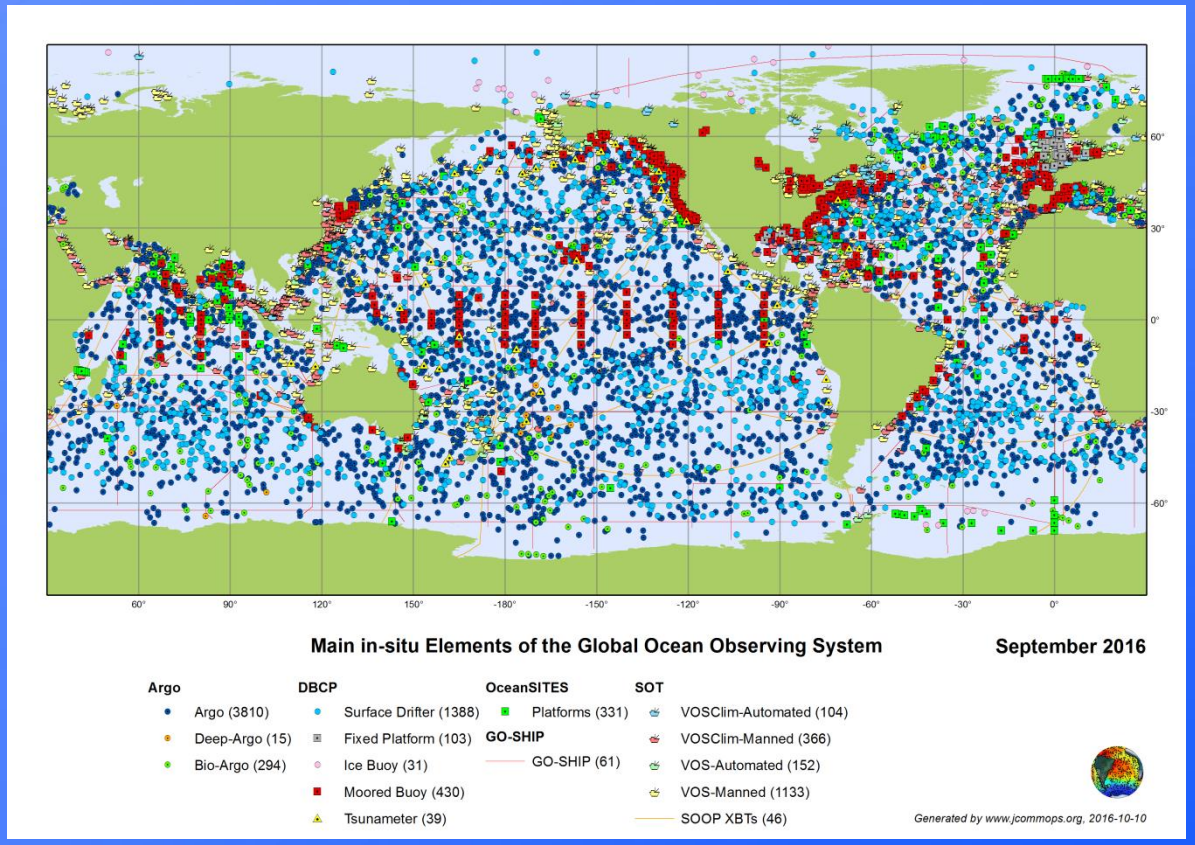
- Sustained in situ and satellite observations of ocean parameters are required to answer fundamental questions concerning the role of ocean physics on climate and vice versa.
- The broad temporal, horizontal and vertical observational scale requirements dictate the need for the requirement of diverse observational techniques and platforms.



- OceanSITES is a network of stations or observatories measuring many aspects of the ocean's surface and water column using, where possible, automated systems with advanced sensors and telecommunications systems, yielding high time resolution, often in real-time, while building a long record.
- There is a need to build and maintain a globally-distributed network of multi-disciplinary fixed-point surface and subsurface time-series using mooring, ship and other fixed instruments, and to establish a coordinated network of ship-based multidisciplinary time-series that is geographically representative.

Thank you!


(a)
Carbon
(PgC)
(b)
Global mean sea level
(mm)
(c)
Upper ocean heat content
(ZJ)
(d)
High salinity minus low salinity
(PSS-78)
Year


Main in-situ Elements of the Global Ocean Observing System
September 2016
Argo
Argo (3810)
Deep-Argo (15)
Bio-Argo (294)
DBCP
Surface Drifter (1388)
Fixed Platform (103)
Ice Buoy (31)
Moored Buoy (430)
Tsunameter (39)
OceanSITES
Platforms (331)
GO-SHIP
GO-SHIP (61)
SOT
VOSClim-Automated (104)
VOSClim-Manned (366)
VOS-Automated (152)
VOS-Manned (1133)
SOOP XBTs (46)
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