The Future of Ocean Observing: Challenges and Opportunities

Dr. Anthony H. Knap
Director, Geochemical and Environmental Research Group
James R. Whatley Professor of Geosciences, Texas A&M University

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Summary

"You can only manage what you can measure"

The commitment to a Sustained Global Ocean Observing System is essential.

This commitment will require new technologies especially to sensors for biology and chemistry and sufficient globally distributed platforms

Governments and the Private Sector need to work together more

Global Ocean Observing System (GOOS)

World Ocean Observing System proposed by Henry Stommel WHOI.

“John Woods - Panel of the Intergovernmental Oceanographic Commission wanted to create the “Wet Office” – ocean analog to “Met Office”.

Started in 1990 – system to be built out by 2007

In 1989 Stommel wrote an imaginative story about “Gliders” roaming the ocean remotely measuring the ocean from a land based “Mission Control”

Where are the Gaps ?

System is not fully built-out – funding issues

Sustainability of systems –not at full operational capacity, many are funded through research programs rather than operational - compete with peer-reviewed science

Deep Ocean (under 2000m) is very under-sampled- issue of technology and cost – Physics more developed than biology and chemistry

There are some winners

Satellites-(sea surface height, Sea Surface temperature, Ocean color for productivity)

Argo

Marine Microbiology/Genomics

Emerging nations are starting to play an important role. South Korea, China, Taiwan, India, Brazil etc. see value in ocean research. (Partnership for Observations of the Global Ocean)

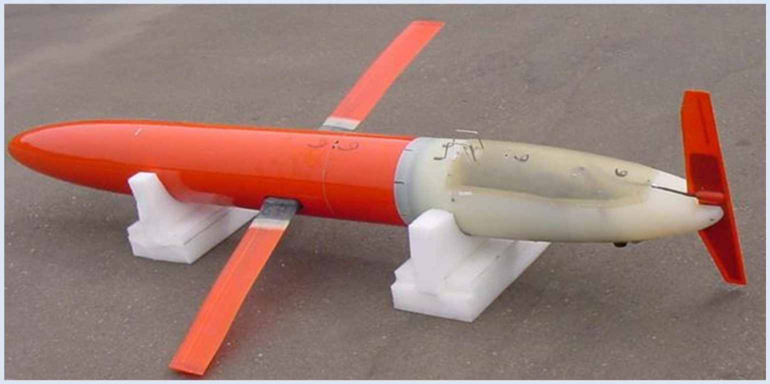
However, we are still a long way from having an integrated and sustained Global Ocean Observing System

From Ships to floats, to gliders to Organisms

By the early 1990s, floats could be deployed anywhere.

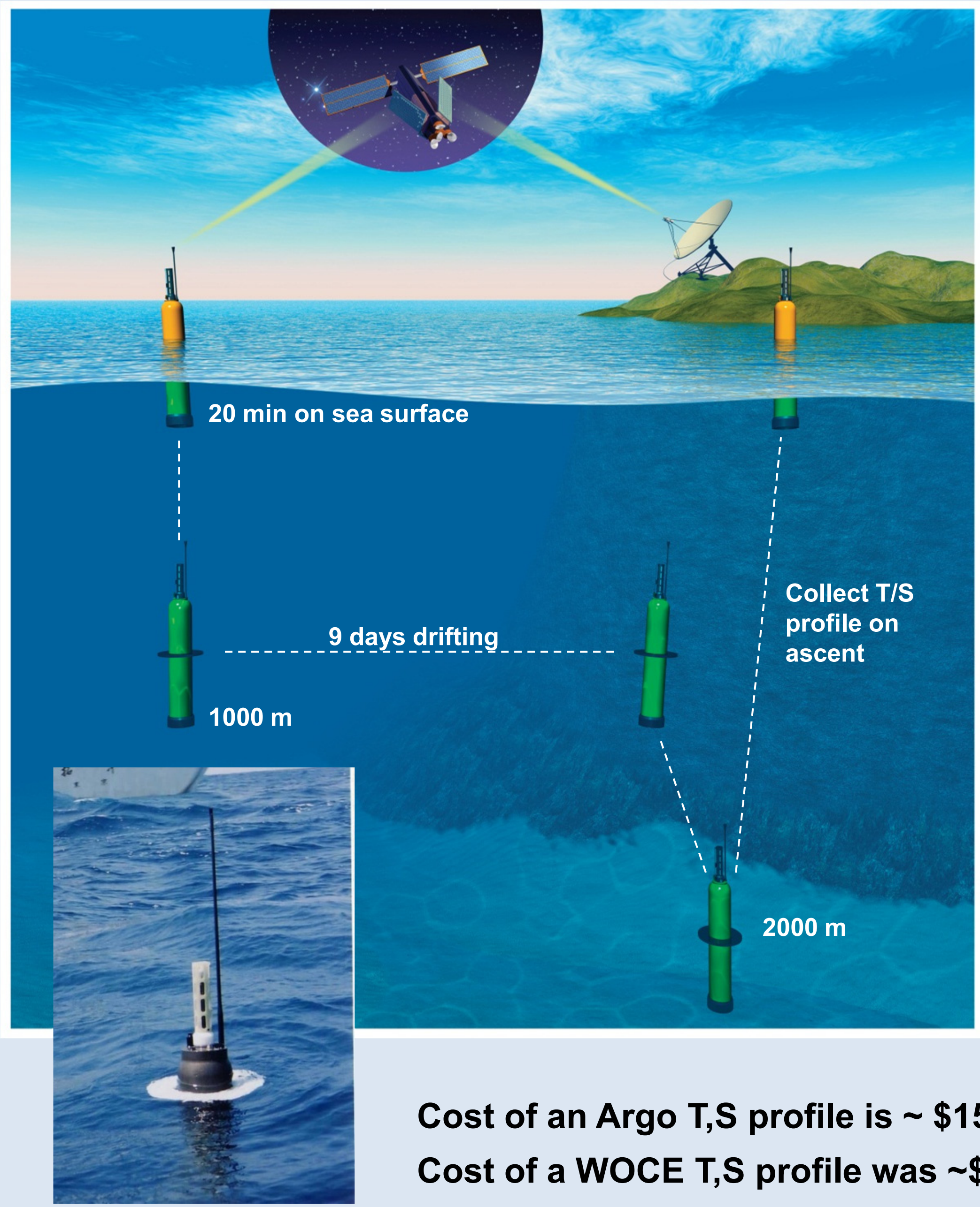
(Davis/Webb) floats returned from 900m every month

Five years later, more sensors were added and the Argo Program was born: A global array of 3000 floats, each returning a profile 0-2000m every 10 days.

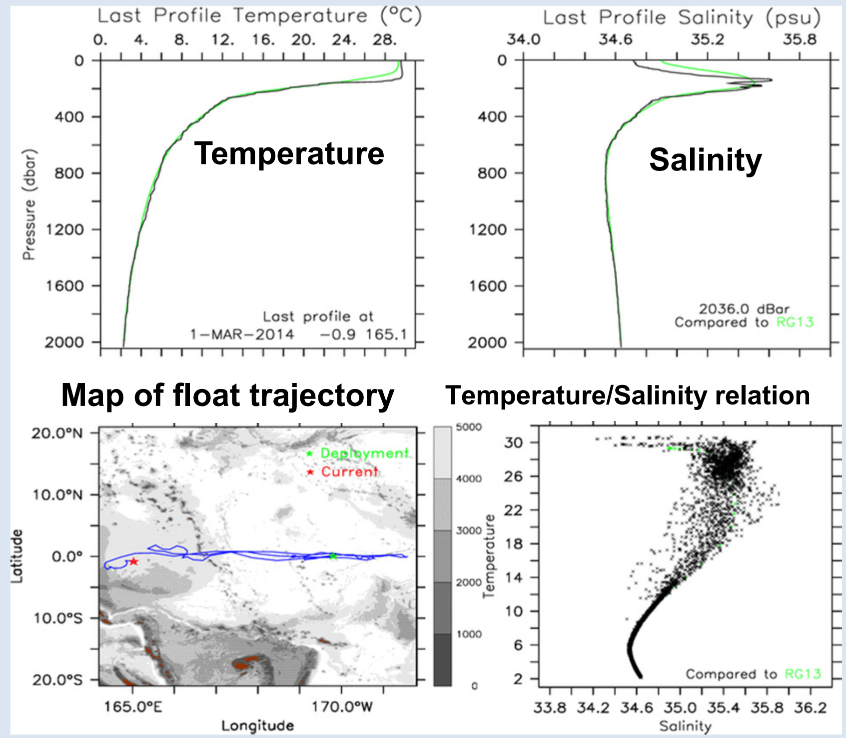


A related technology, the glider, is a profiling float with positioning control.

How do Argo floats work?



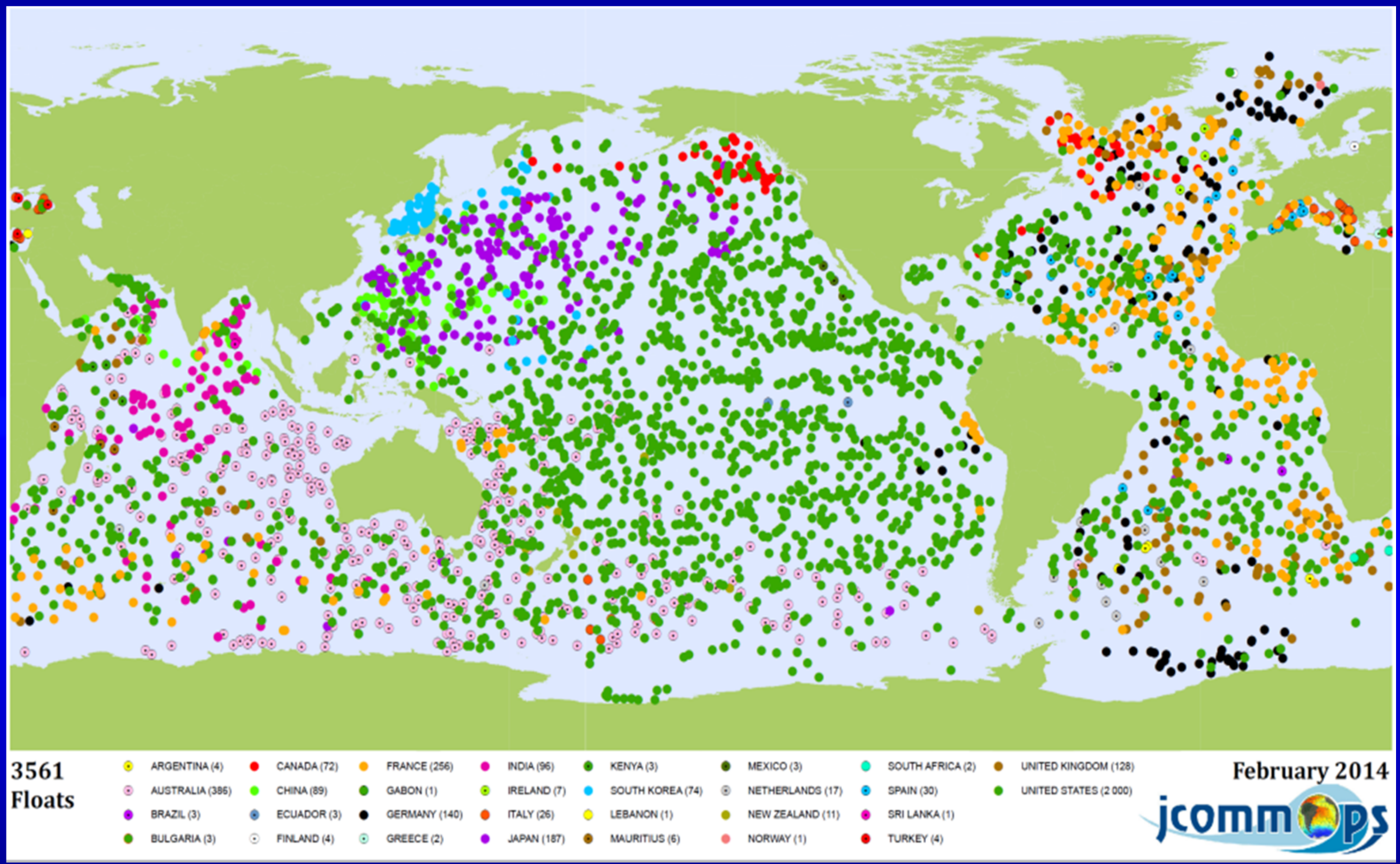
Argo floats collect a temperature and salinity profile and a trajectory every 10 days, with data returned by satellite and made available within 24 hours via the GTS and internet (http://www.argo.net) .



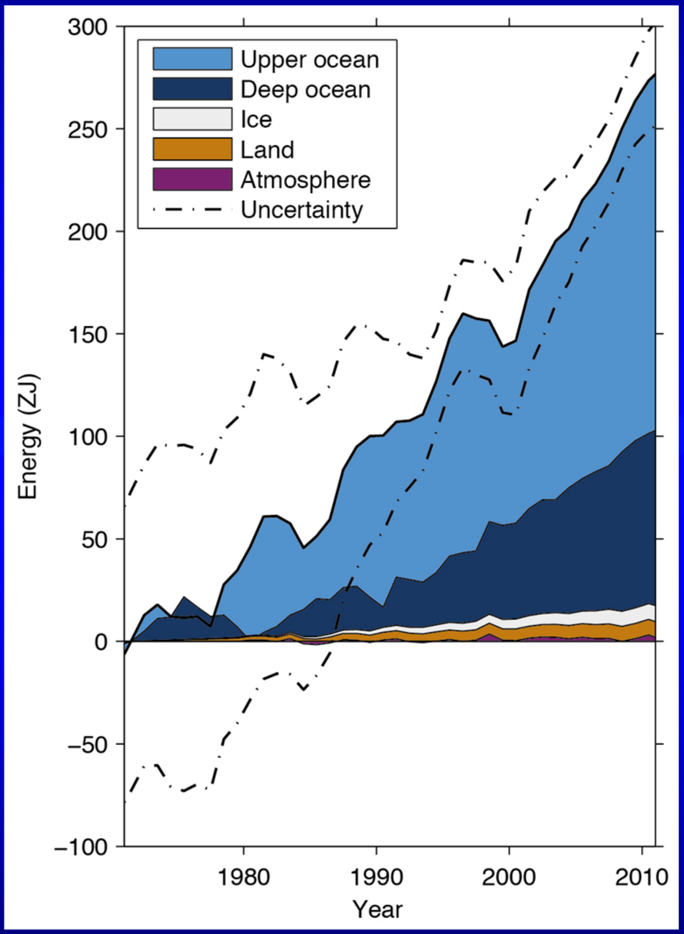
Cost of an Argo T,S profile is ~ $150 (all-inclusive).

Cost of a WOCE T,S profile was ~$15,000

February 2014 (30 Nations) – 3600 floats



IPCC 5th Assessment Chapter 3 – the importance of the ocean to global heat

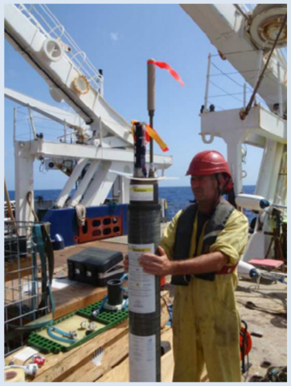


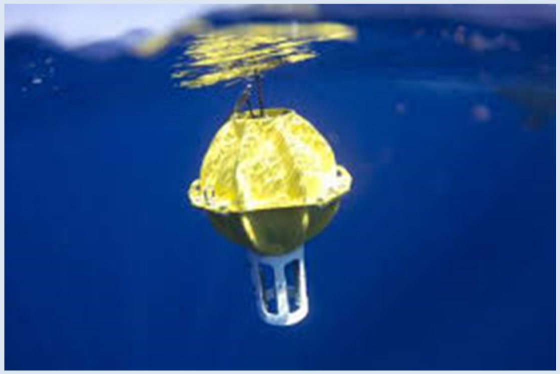
Deep Argo (Wijffels/Roemmich)

The Deep Ocean

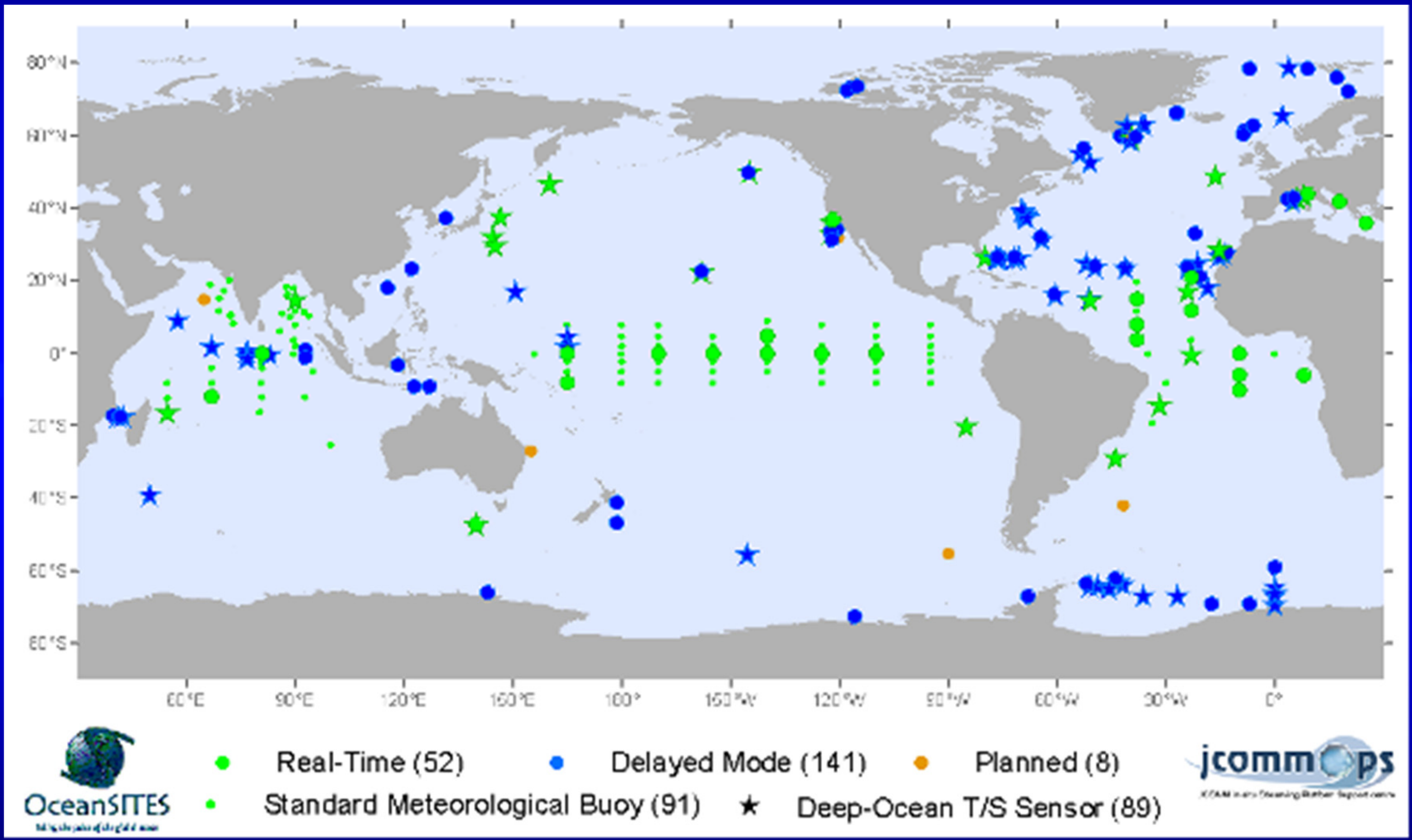
Deep floats are being developed and tested by several groups – up to 6,000m

A new CTD sensor is under parallel development with improved stability for the smaller changes in the deep ocean





Oceansites Network (fixed platforms) – mainly physical parameters

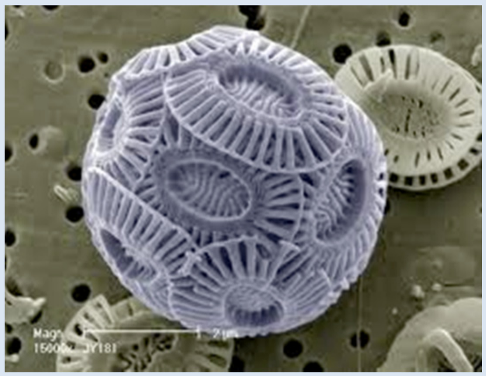


Marine Ecosystem Changes are Undersampled

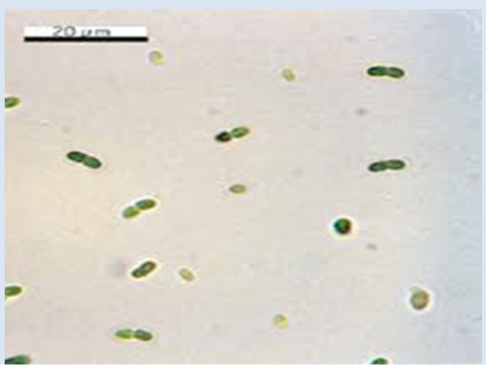
Phytoplankton

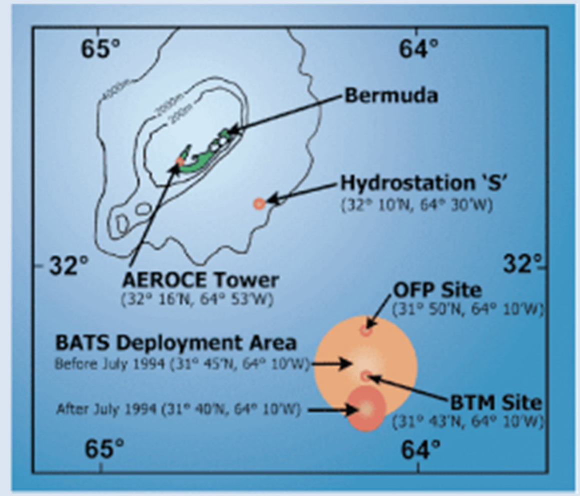
Fewer Diatoms

Fewer Coccolithophores



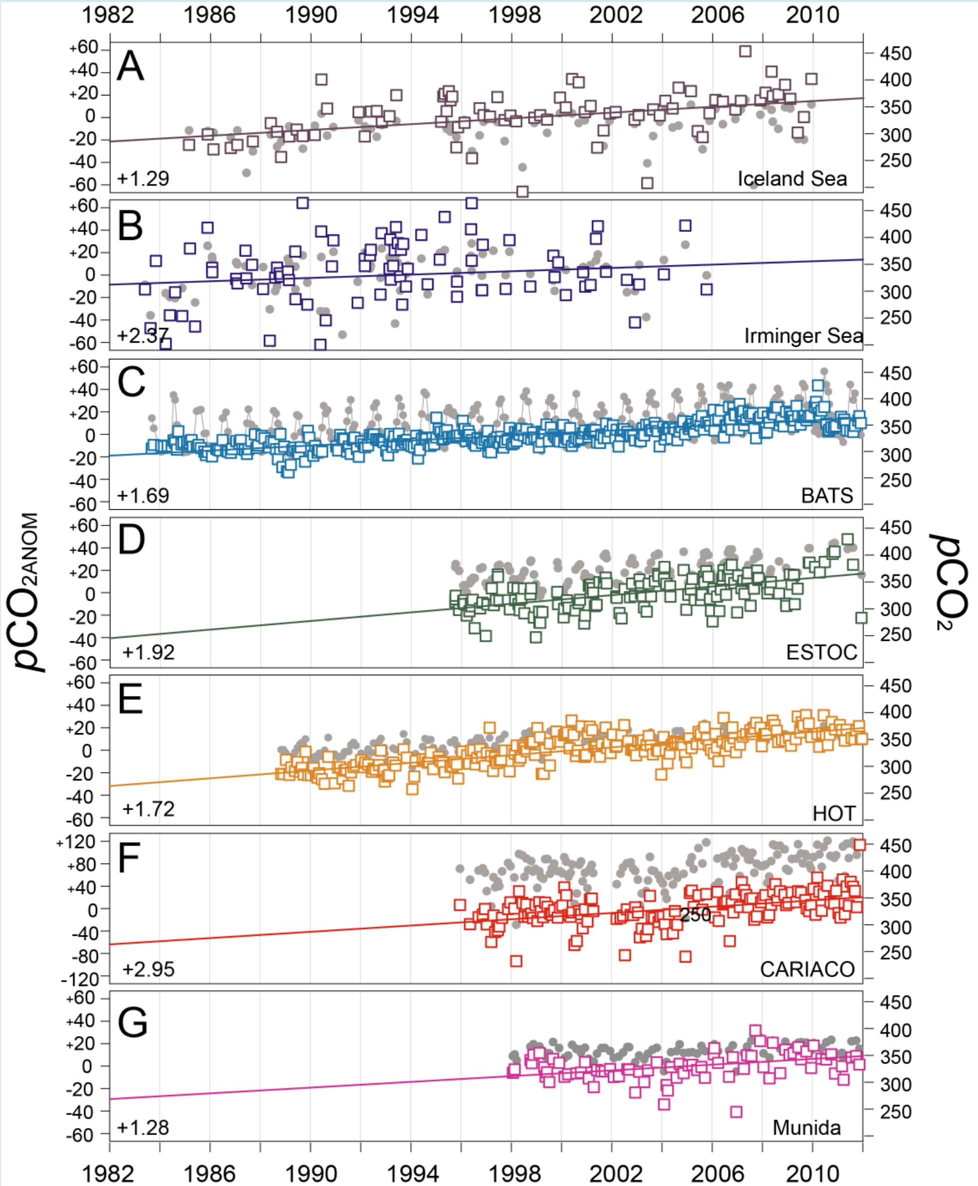
More small phytoplankton (synechococcus)

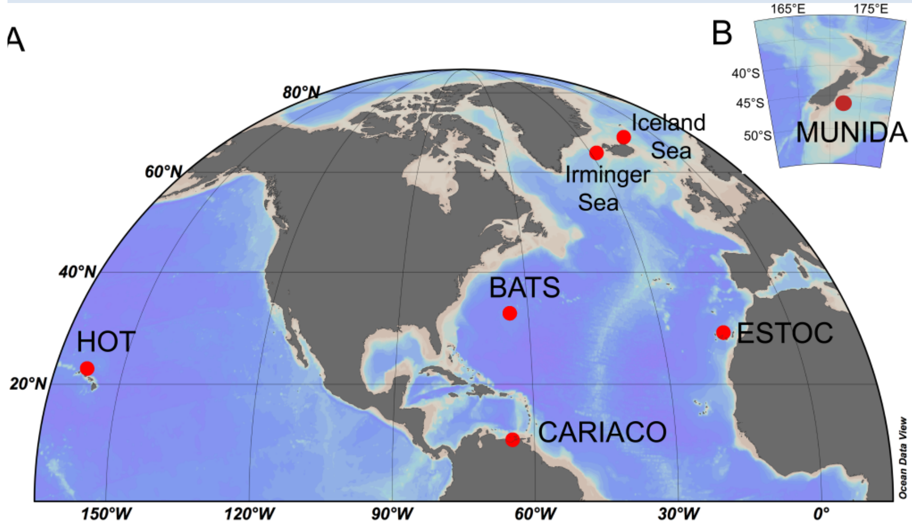




Mike Lomas, Bigelow

Changes in Ocean CO_2 Content





***p*CO_2 changes =**

+1.38 to +2.95 µatm year^{-1}

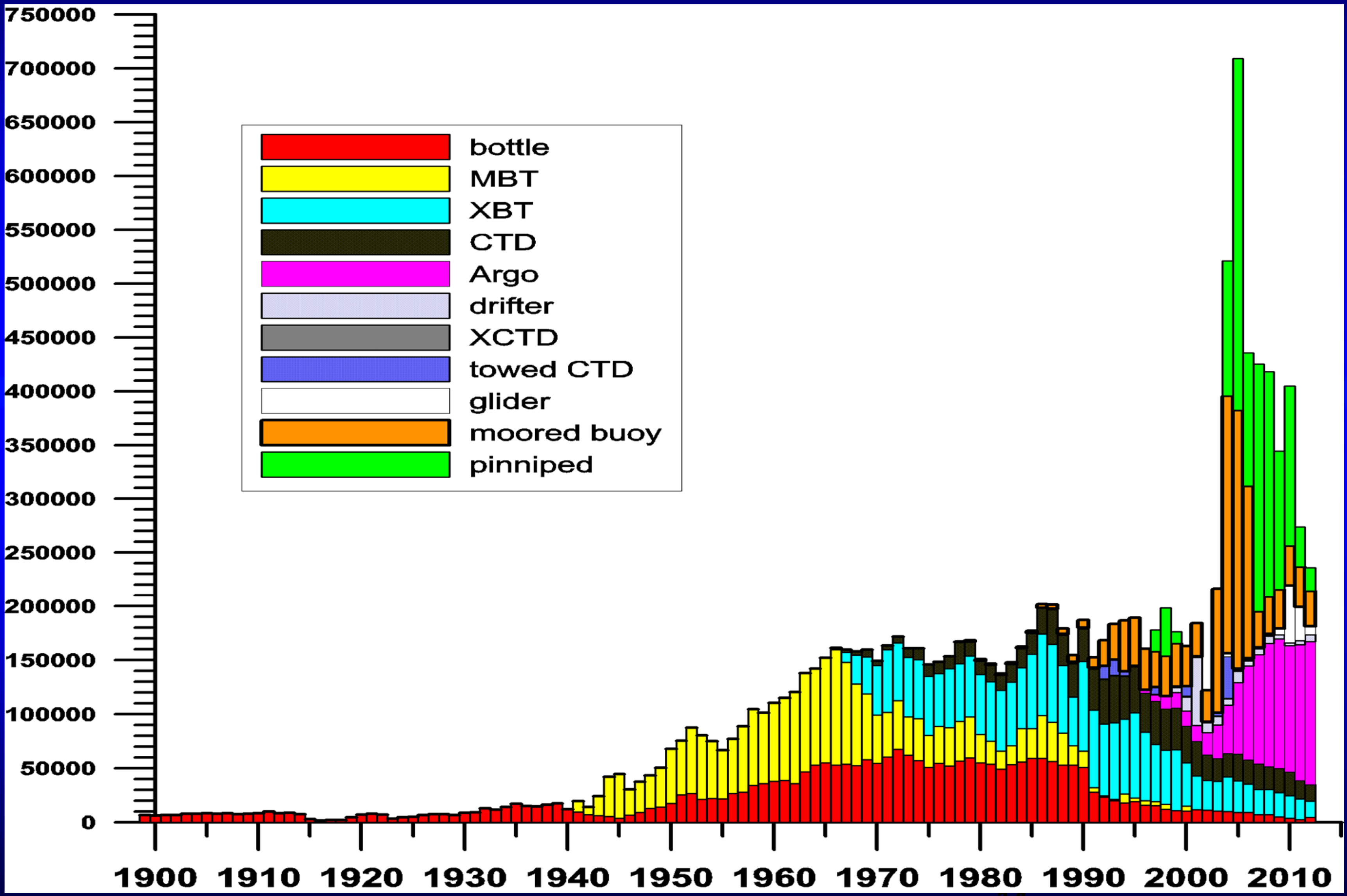
or about 3 to 9% per decade

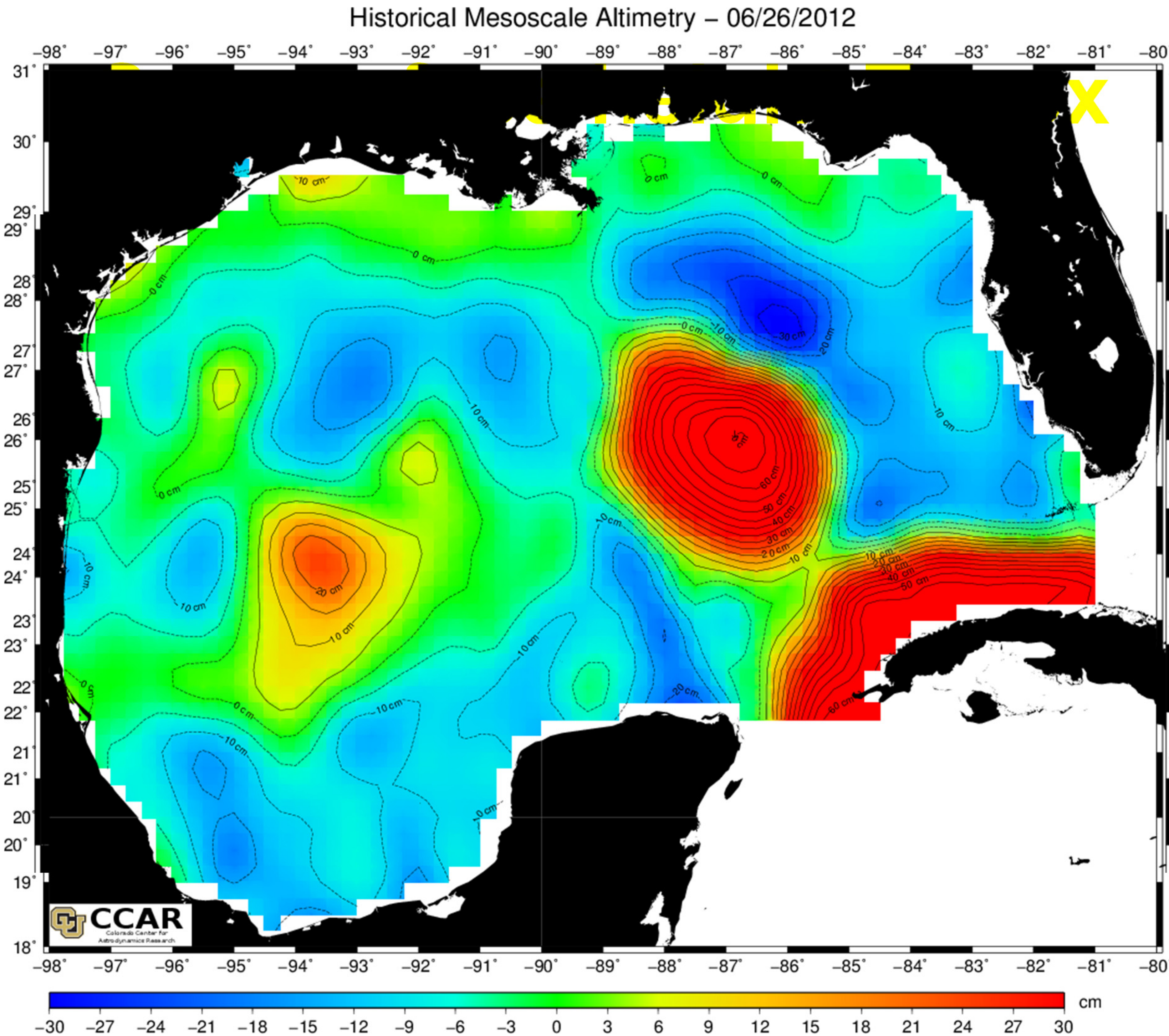
Seasonal observations are critical to determine changes over a few decades

Bates et al., 2014. *Oceanography*

Bates et al, Ocean Sciences Meeting, Feb 2014

World Ocean Database by Instrument Type

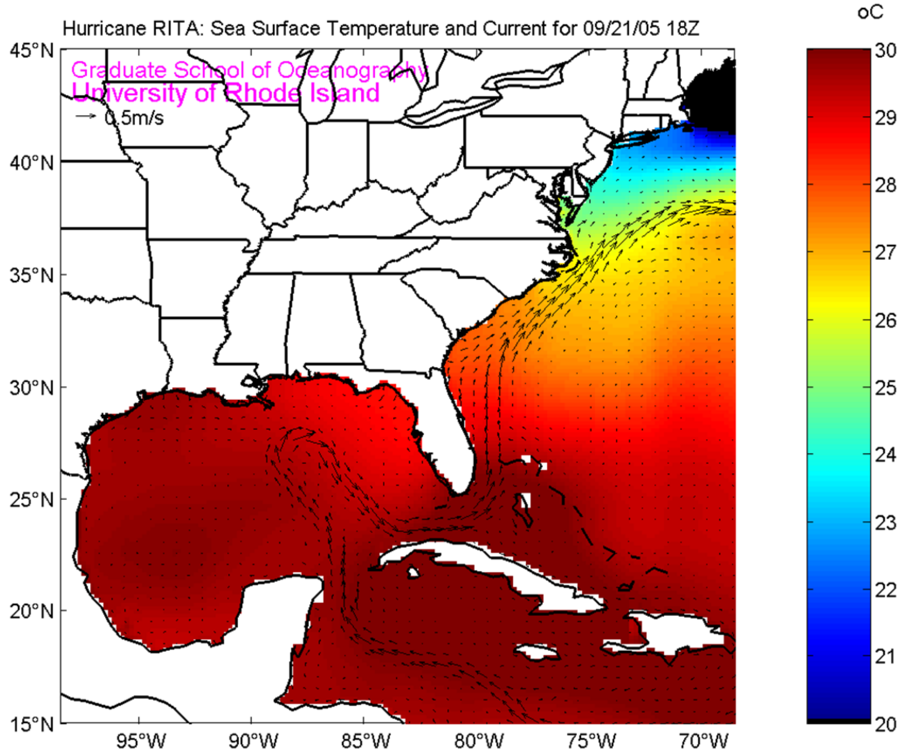


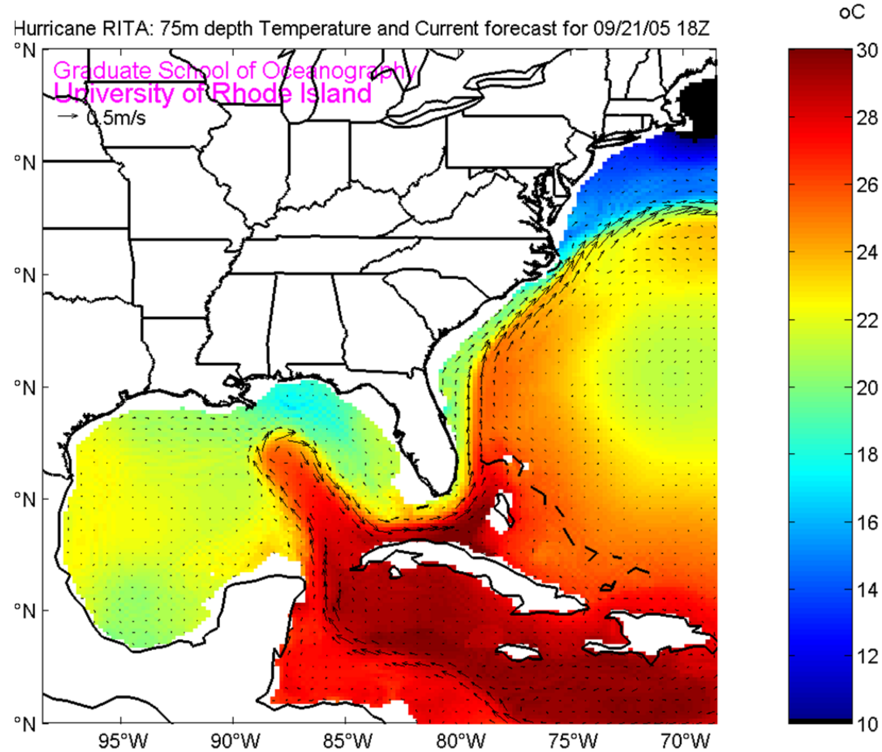


Historical Mesoscale Altimetry – 06/26/2012
CCAR
Colorado Center for Astrodynamics Research
cm

Gulf of Mexico temperature prior to Rita (Ginis)

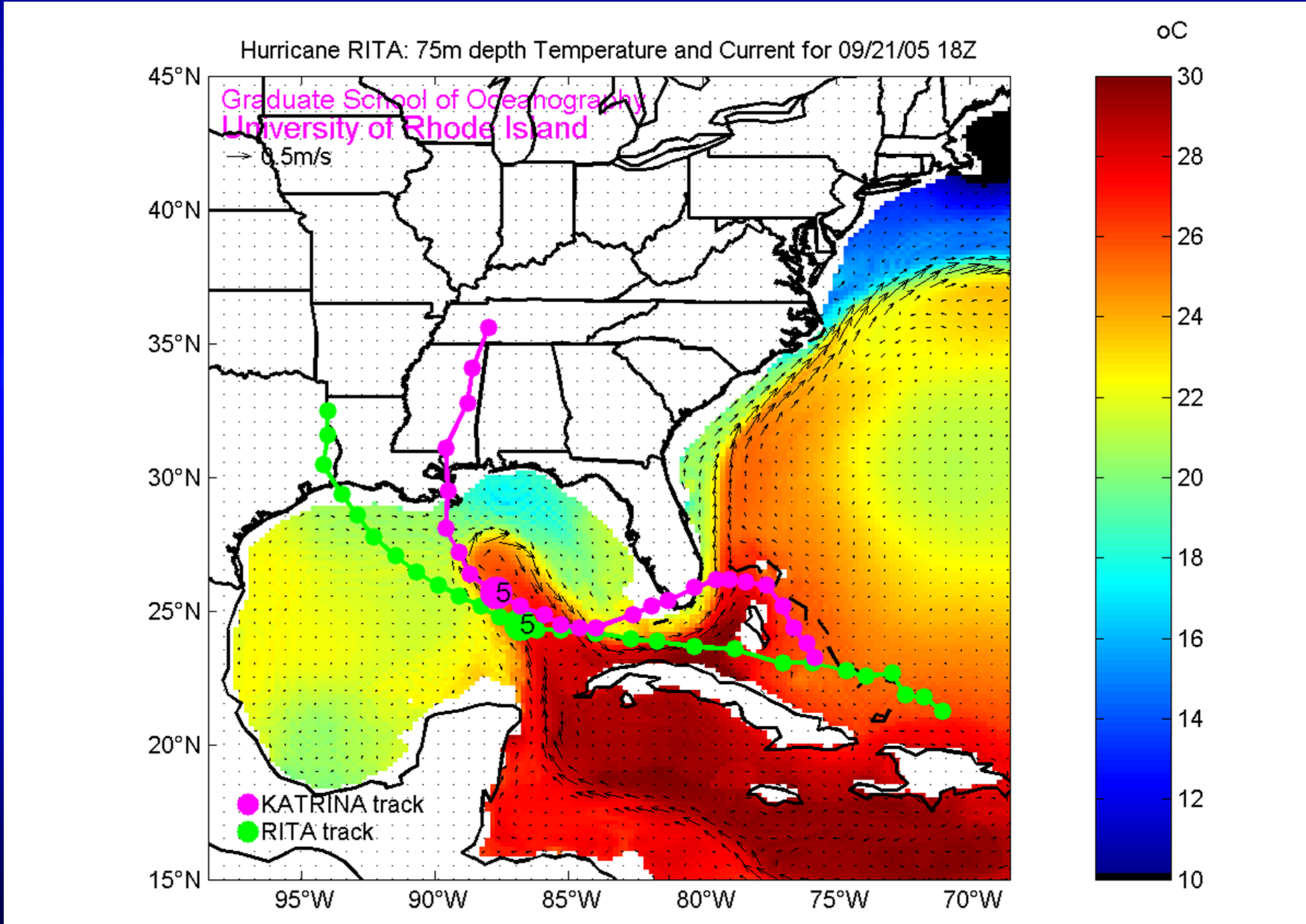
Sea Surface | **75 m depth**





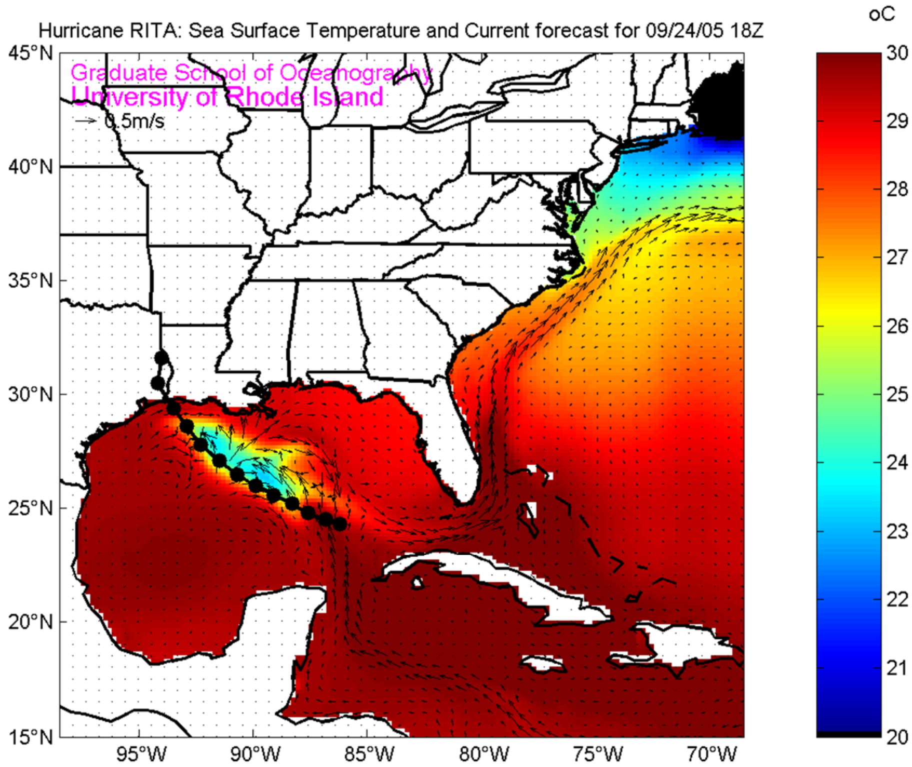
Courtesy Isaac Ginnis

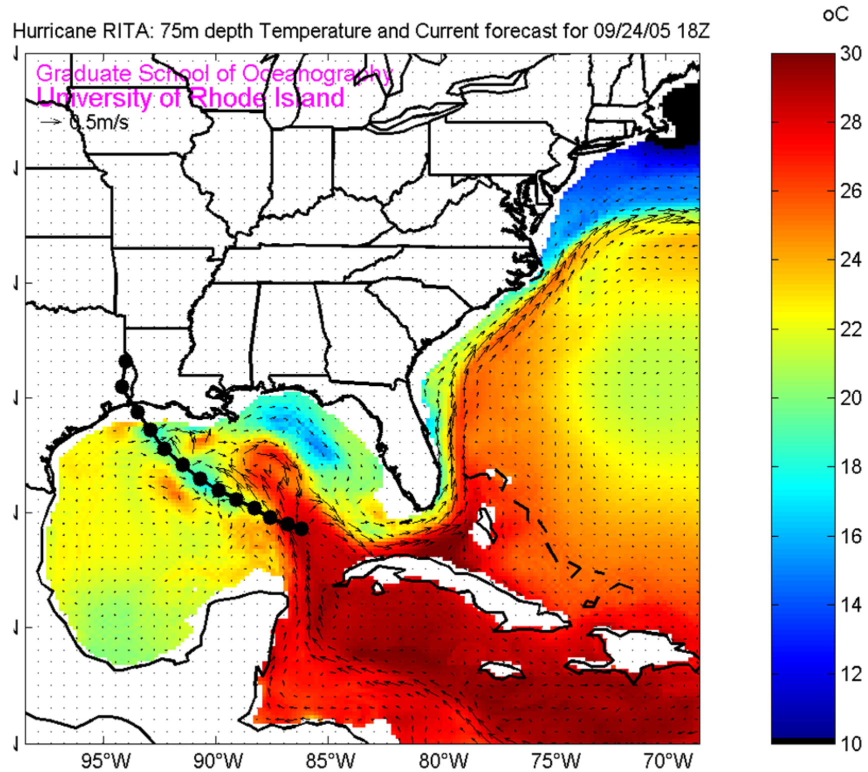
Hurricane Rita rapid intensification due to upper ocean heat content "Live Cat" (Ginis)



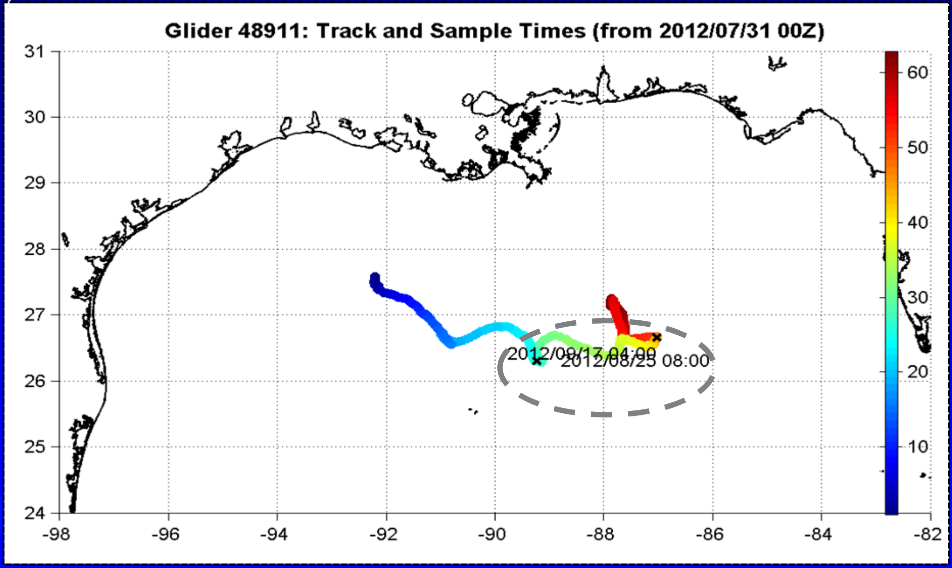
Hurricane Rita

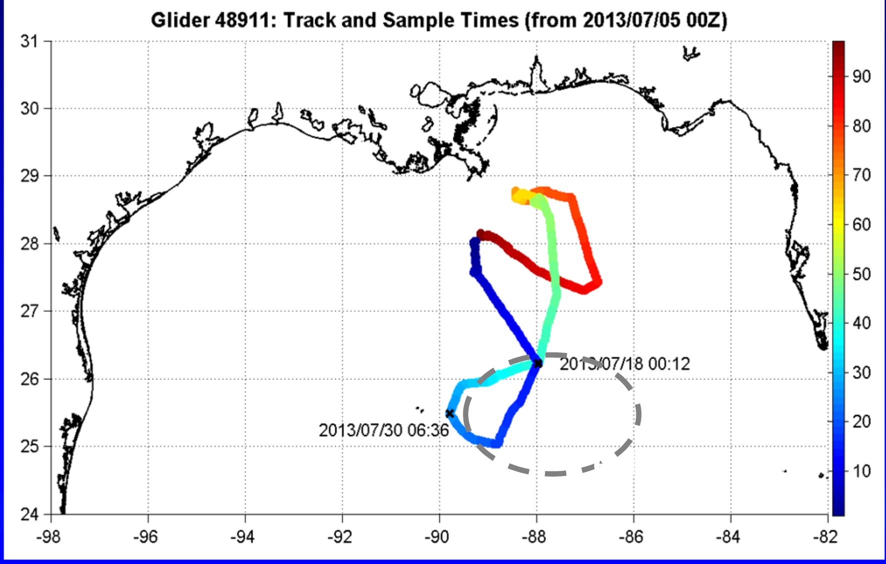
Sea Surface | **75 m depth**

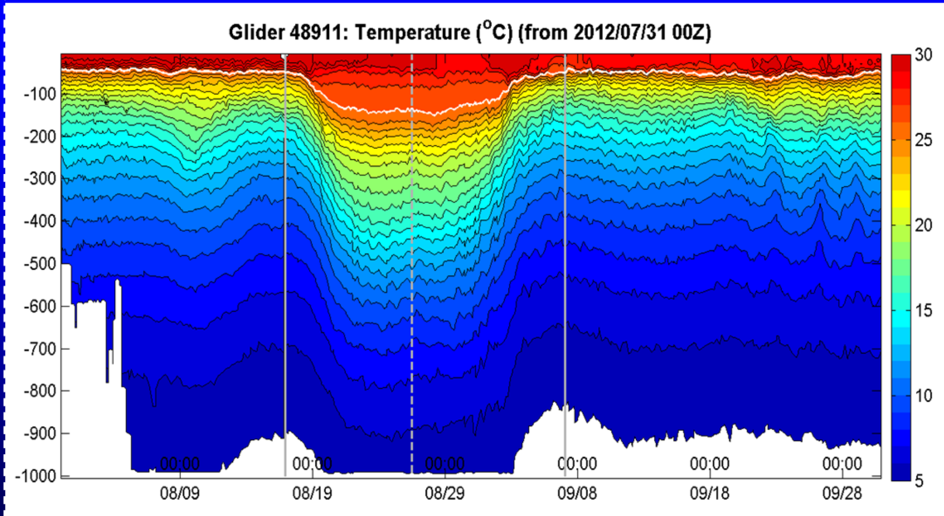


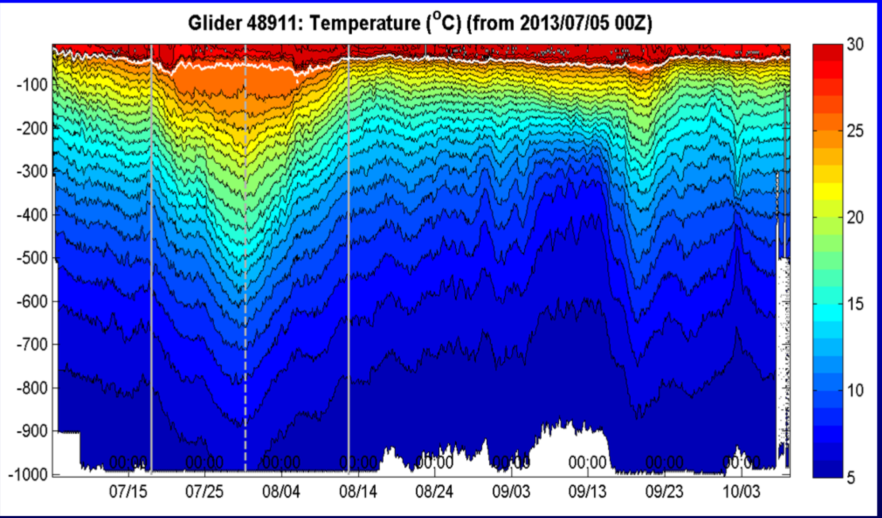


NOAA Gliders Gulf of Mexico 2012 and 2013

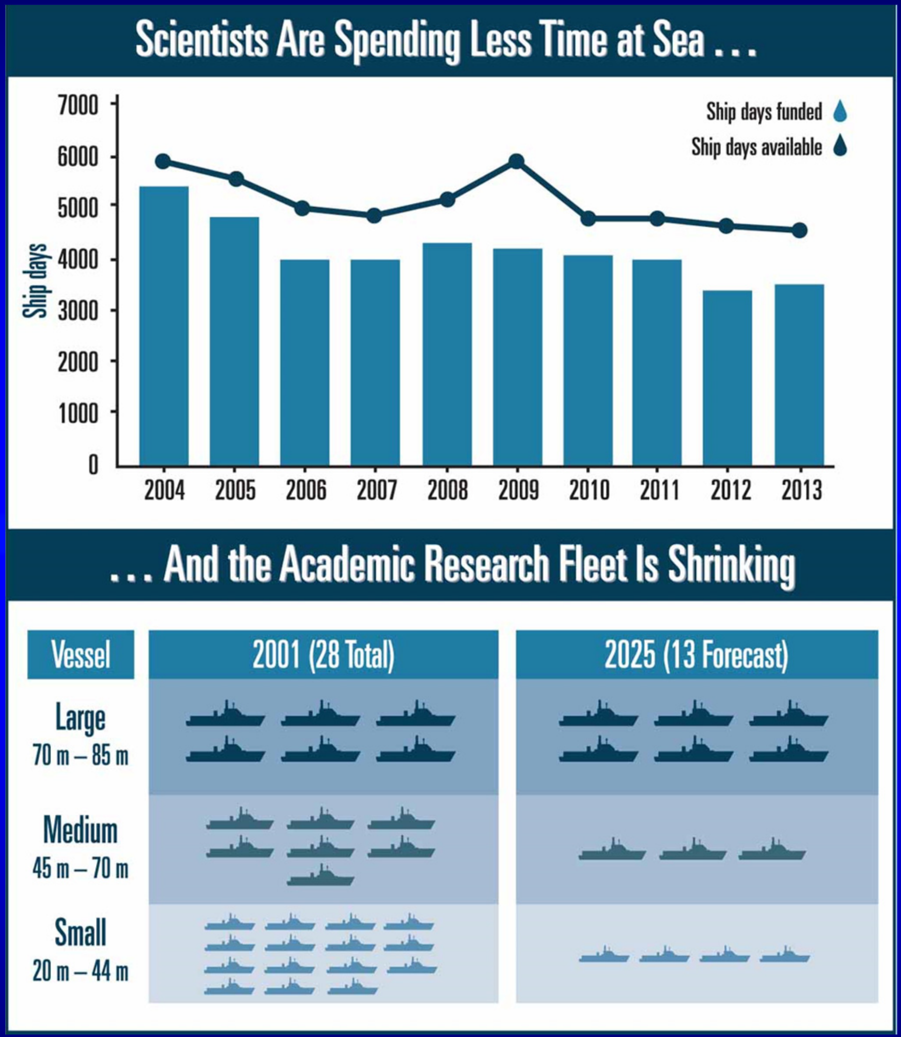






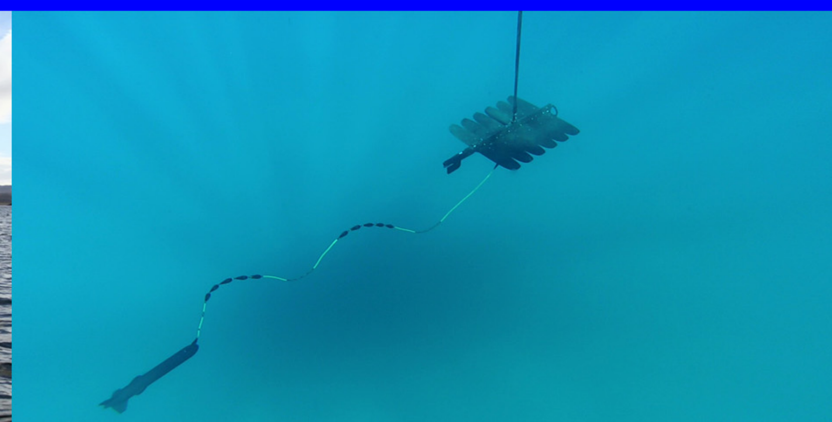


Landlocked?Fewer ships and less money mean getting to sea is increasingly challenging for university researchers.



E Kintisch Science 2013;339:1138-1143

Emerging Technologies Autonomous Surface Vehicles (wave powered) - Deep Ocean Gliders

Global-scale oceanography (including ocean temperature measurements) began with the Challenger Expedition (1872 – 1876) (Wijffels/Roemmich)

HMS Challenger

Track of the Challenger Expedition, 1872-1876

Return of the Challenger 140th year (Rutgers)