Ocean Observations for ‘Climate’

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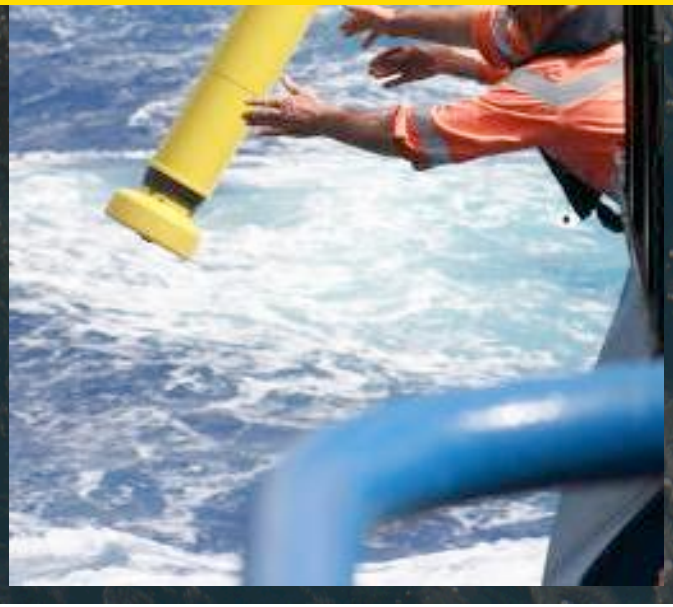
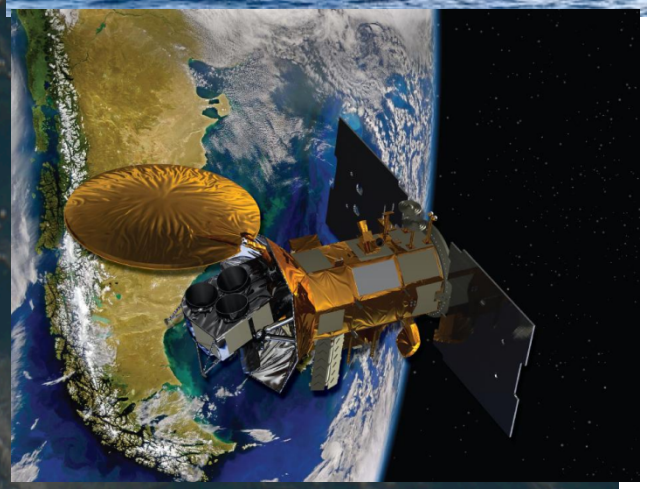
based largely on the community contributions to the OceanObs09 conference [oceanobs09.net]





Why do we care?

- The oceans are the fly wheel of the climate system
- Ocean thermal inertia is a key source of climate predictability – the longer the prediction time the deeper we have to measure
- Ocean fluxes dominate the global hydrological cycle
- Oceans play a key role in the global carbon cycle
- They are a major source of protein for many nations
- Growth in our energy supplies are coming from the ocean: offshore oil and gas

Key Applications

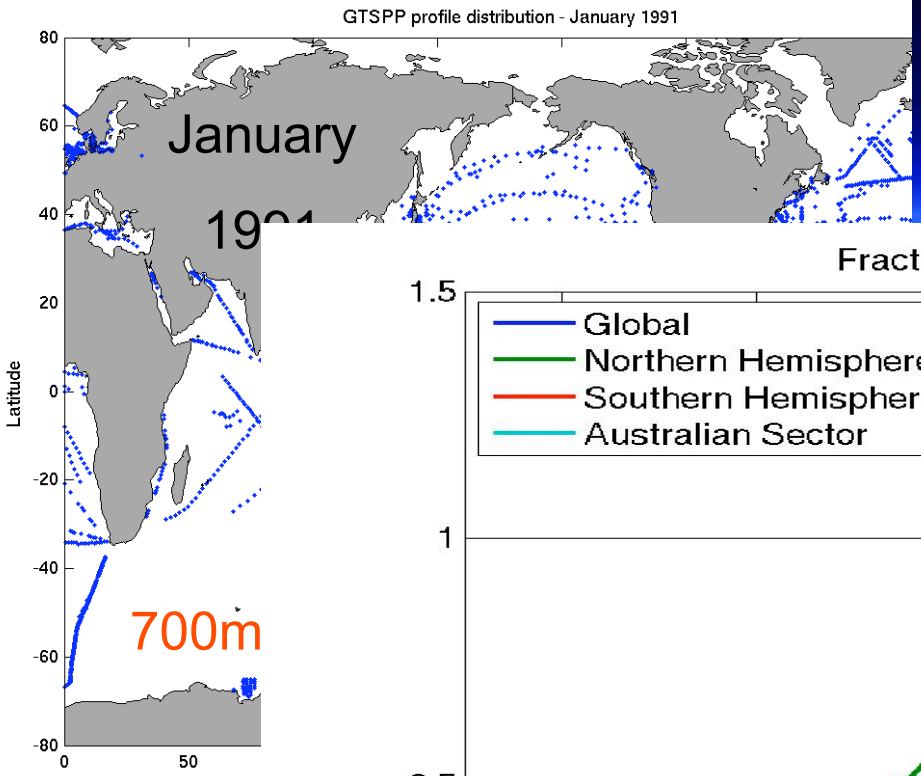
- Initialization and testing of seasonal through decadal prediction
- Improving climate scenarios/projections
- Detection/Attribution of climate change and extreme events
- tracking the global carbon balance
- Ocean mesoscale and its impacts on local weather and climate
- Short term ocean forecasting – marine industry operations/oil spill tracking/search and rescue
- Managing marine resources (fisheries/ aquaculture)

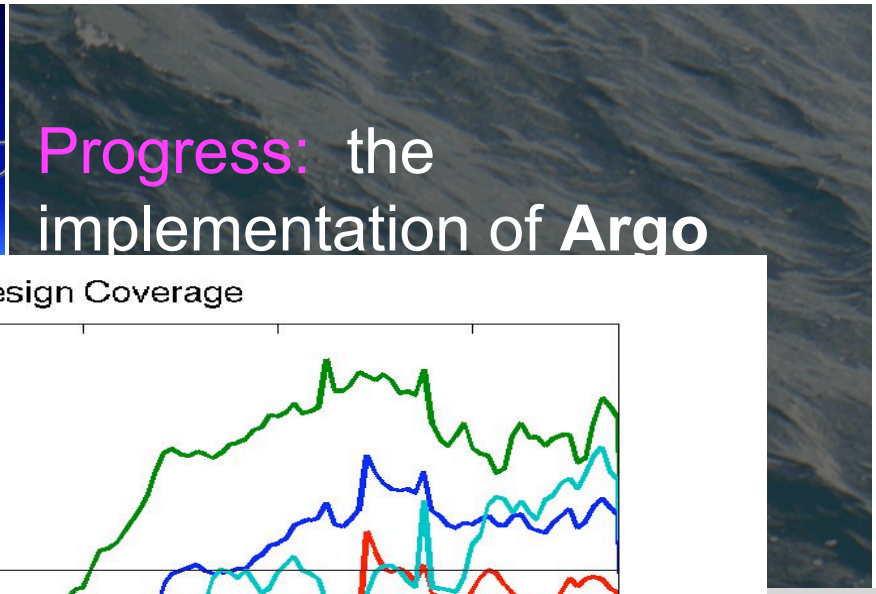
The Generic Challenges

- Sustaining core existing systems – building on progress
- Filling major gaps: increased coverage; increased resolution; richness
- Reconstructing the climate record: retrieving past data: data archaeology, digitisation, quality-control, bias removal
- Transitioning systems built for short term forecasting to service the needs of climate monitoring/prediction
- Provide clear and timely information on the state of the ocean and climate system: contributing to climate services

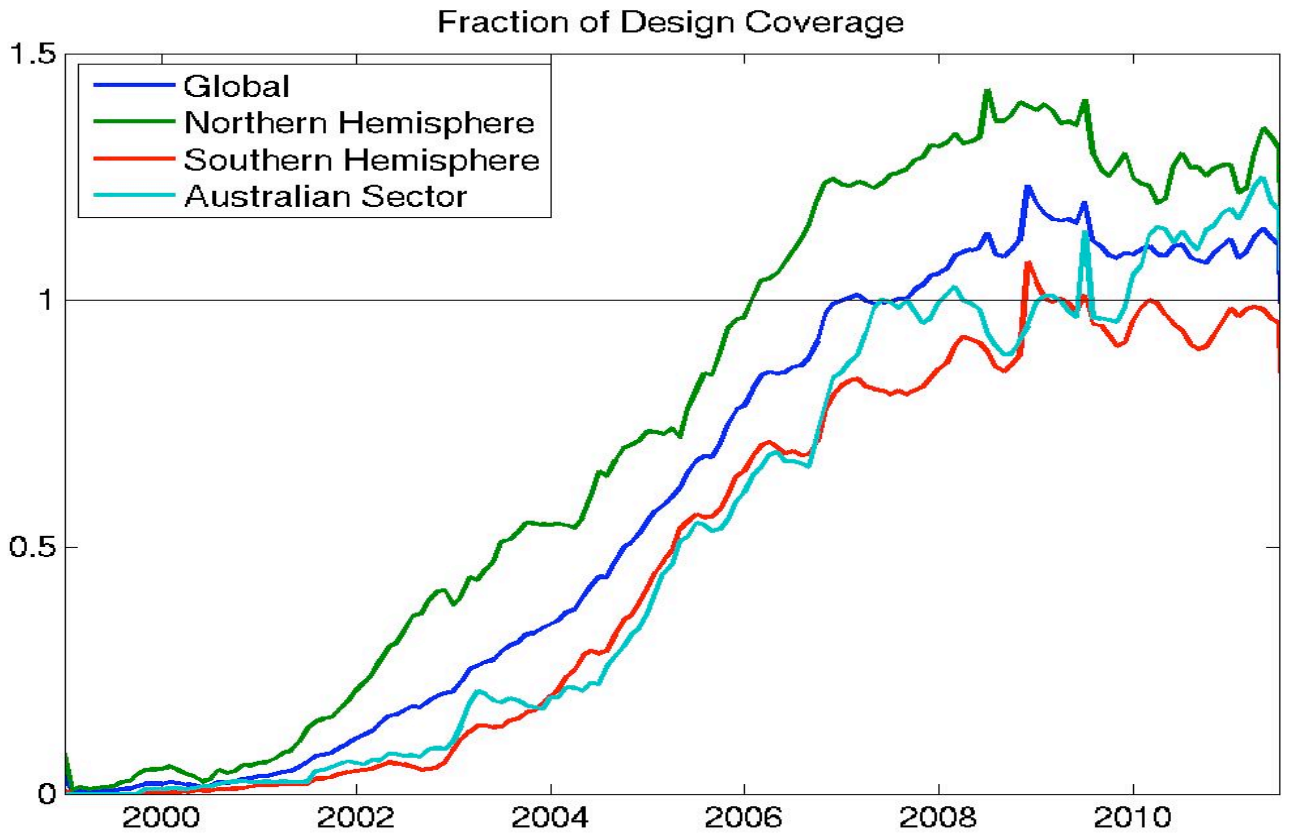
Progress in the last 10 years

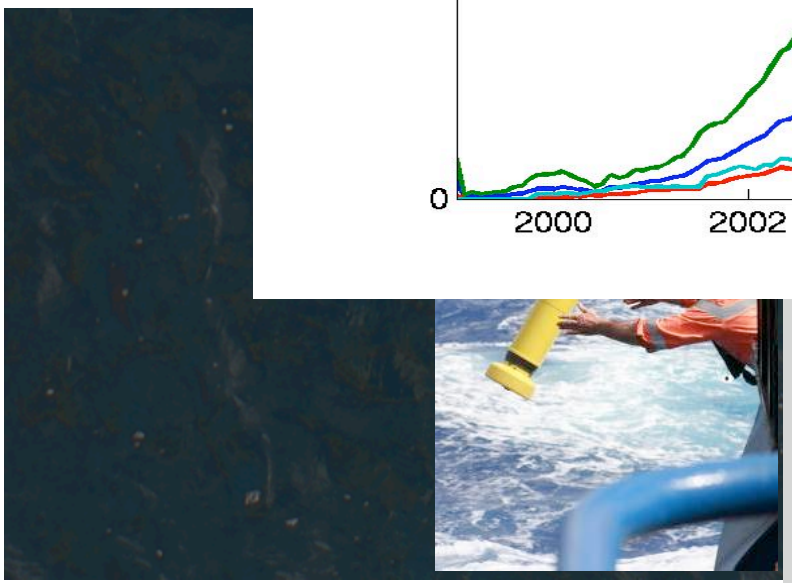
- Major improvements in the reach and seasonal coverage of broadscale ocean profile returns - Argo
- First global salinity monitoring capability –Argo+Aquarius
- Re-tasking of the XBT network from broadscale mode to transport monitoring
- Expansion of coverage of the Tropical Moored Array to cover all tropical oceans
- Improvement in the global distribution and number of surface drifters for SST
- Continuous high precision satellite altimetry since 1992
- GHRSST Project – reinvigorated the science of SST estimation – new and better SST products (with errors)
- Established ongoing global repeat hydrography -GOSHIP
- We have the bones of an ocean carbon observation network

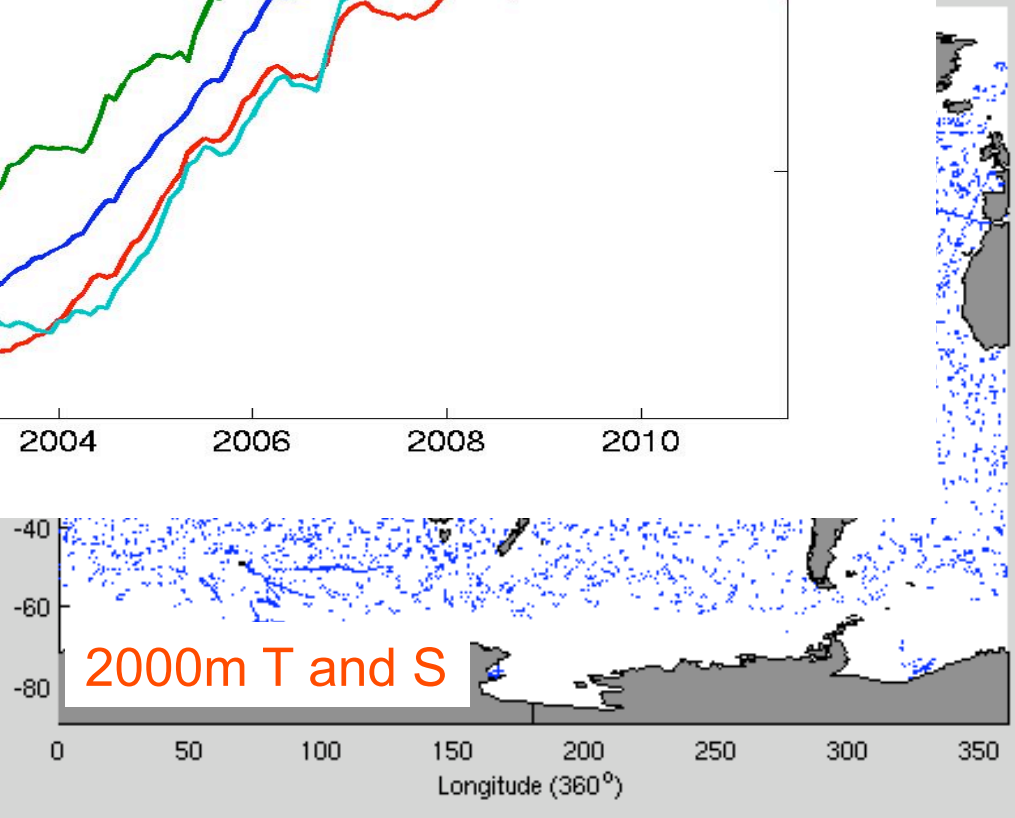




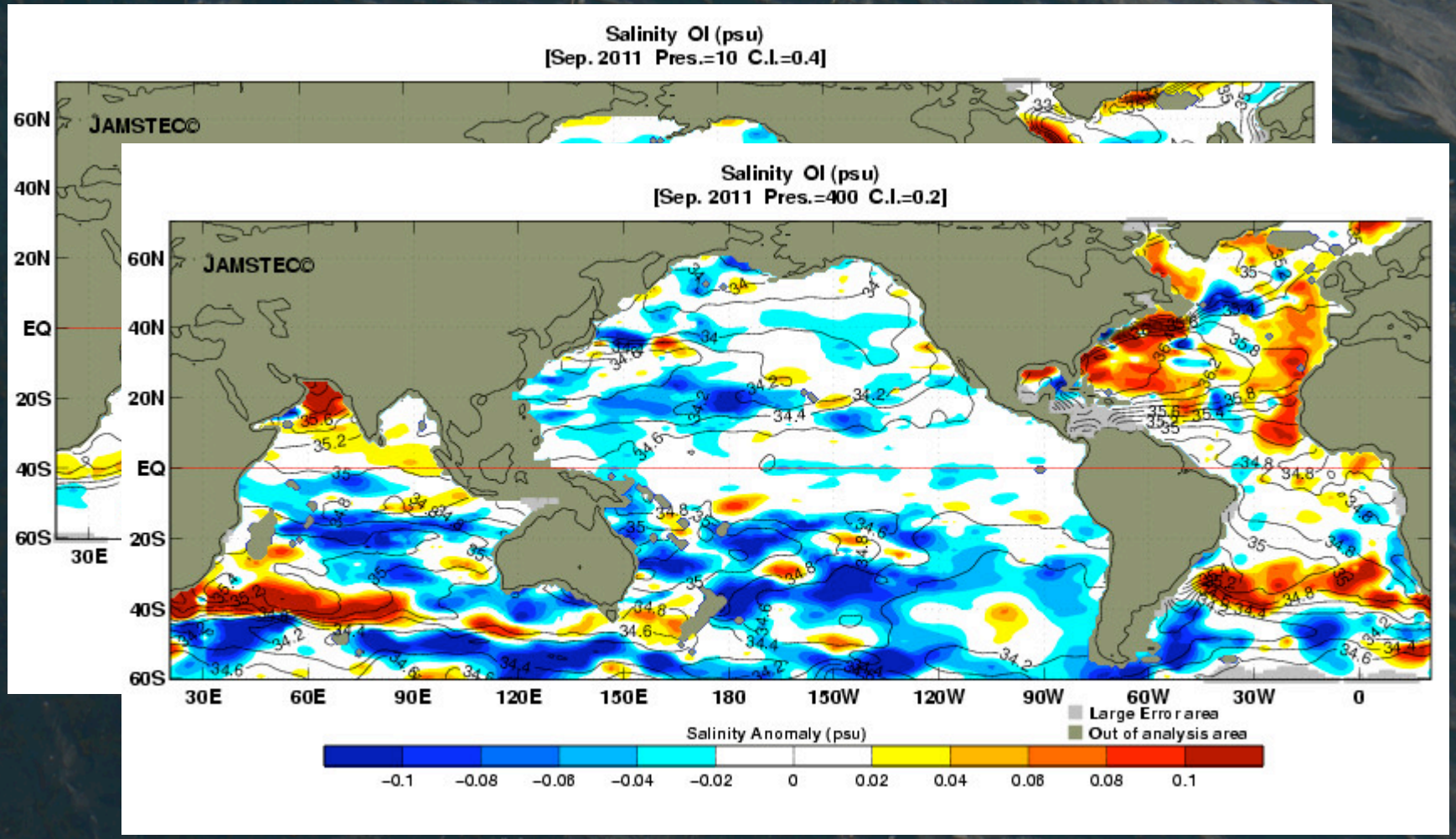
Progress: the implementation of **Argo**





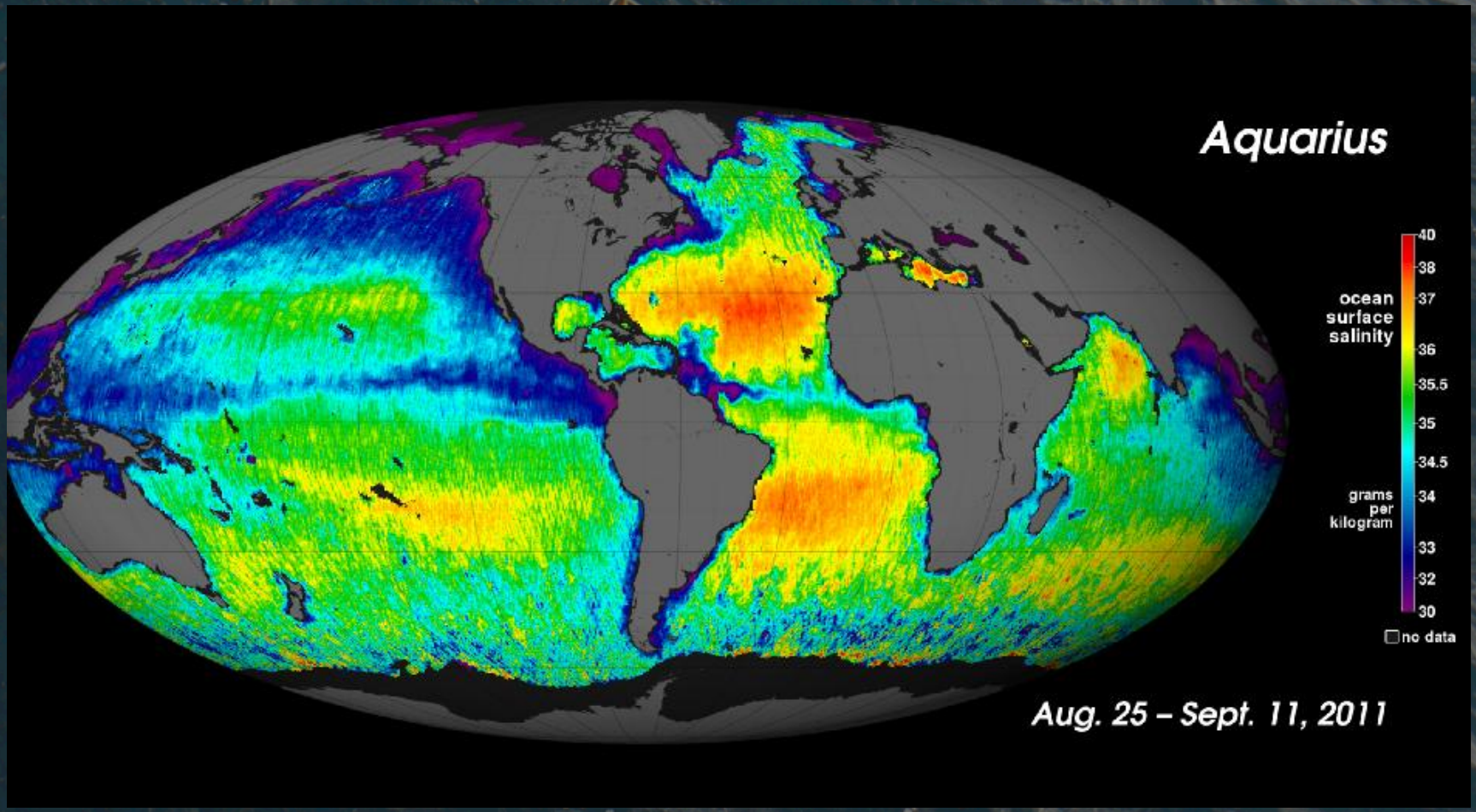


We have a global ocean salinity observing system for the first time



http://www.jamstec.go.jp/ARGO/argo_web/prod/oi_prs_e.html

Progress: surface salinity from space – a promising new capability



NASA

WCRP Open Science 2011

Progress: Retasking of the XBT network to monitor the circulation and boundary currents

- Complement Argo/altimetry
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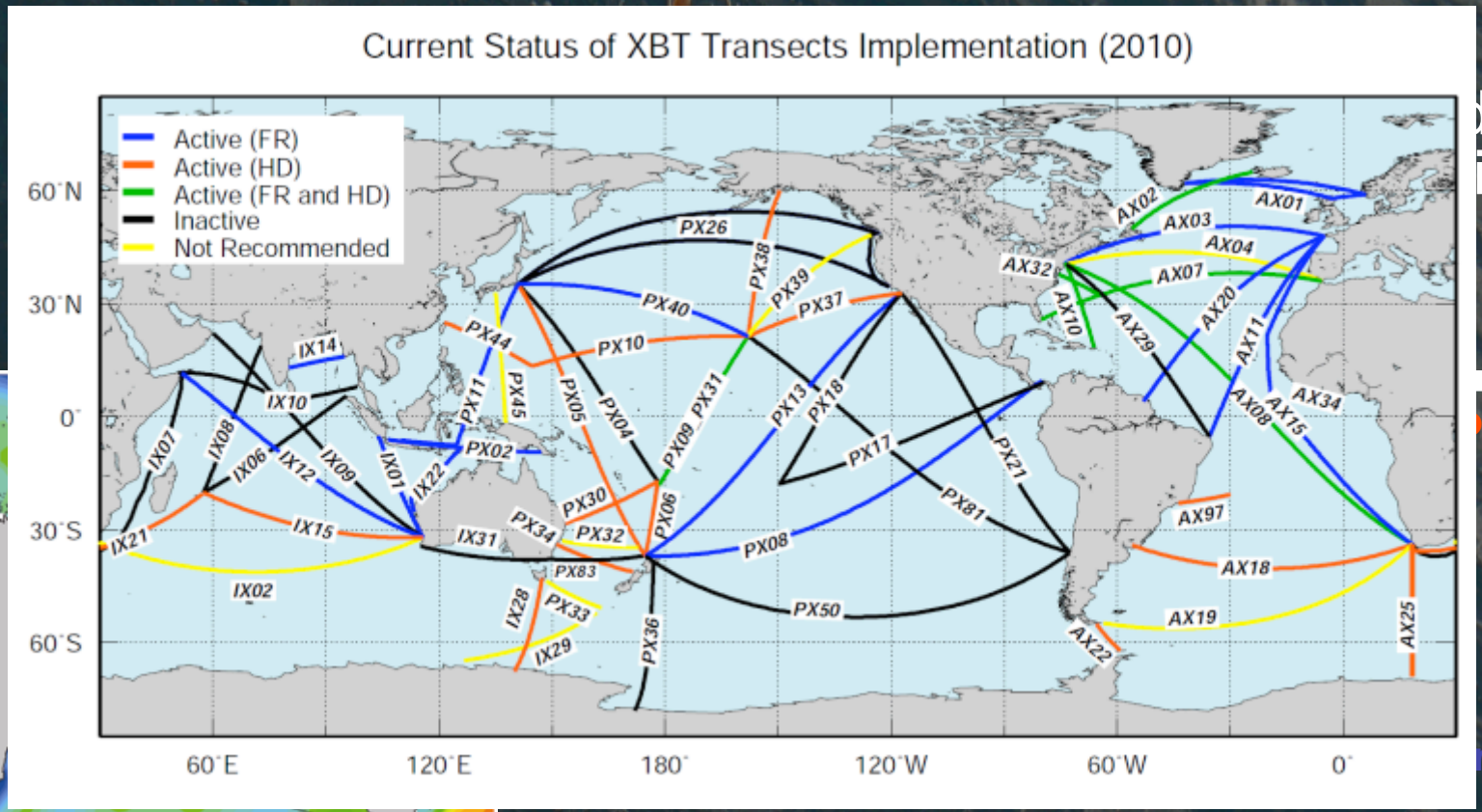
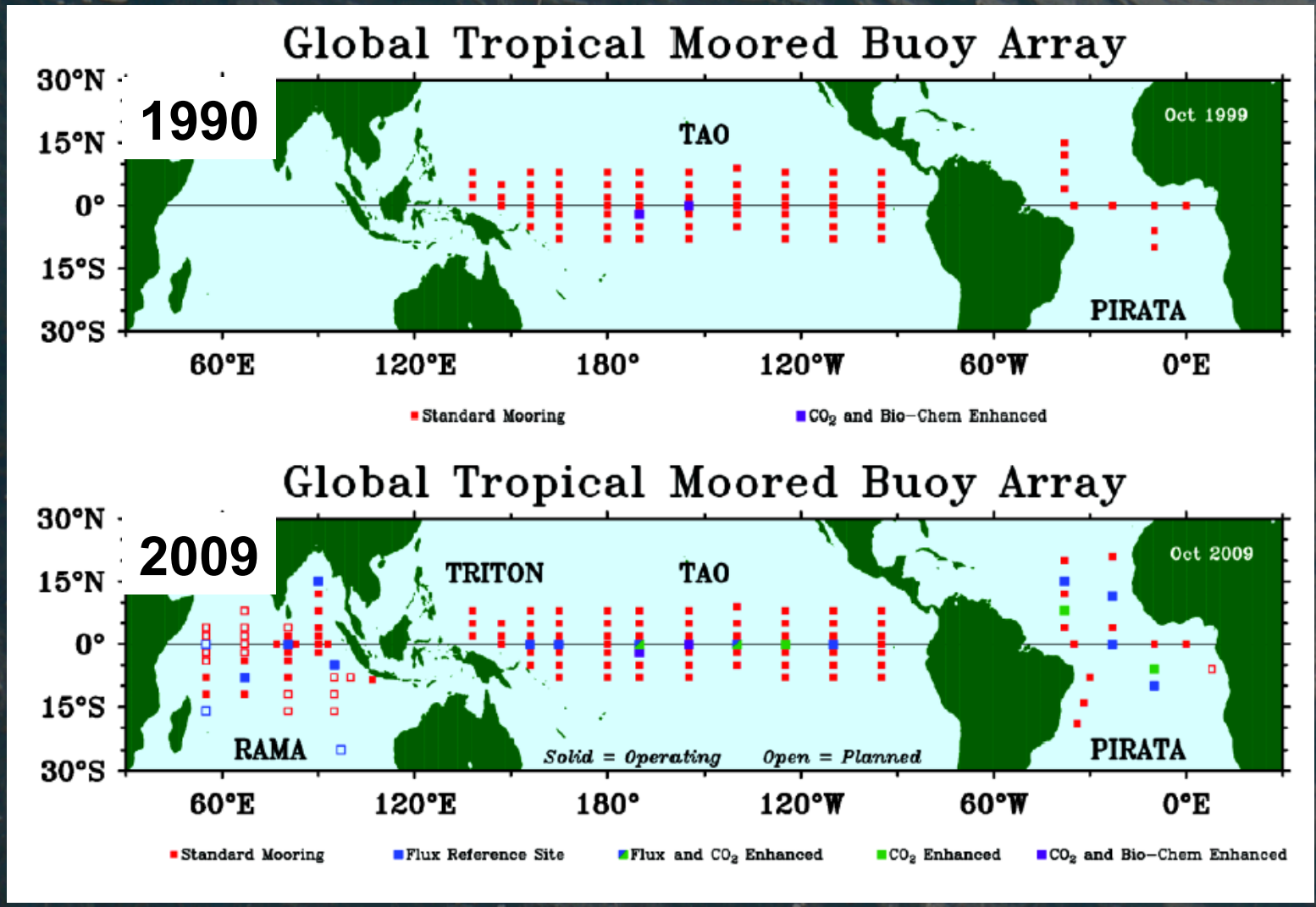


From Ken Ridgway, CSIRO

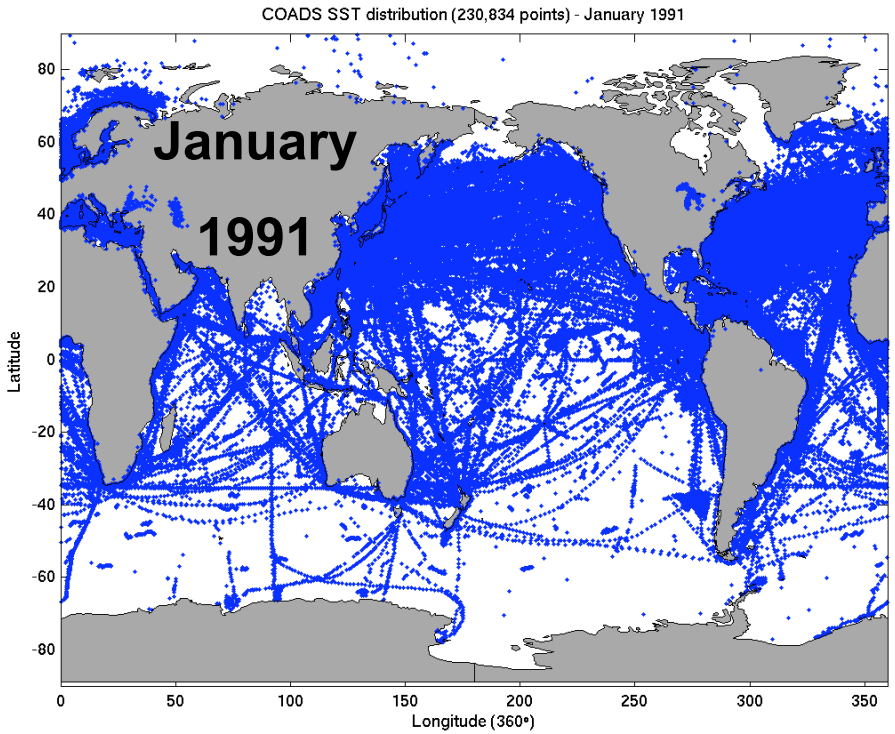
Progress: Tropical Moored Array expands into the Indian and Atlantic Oceans



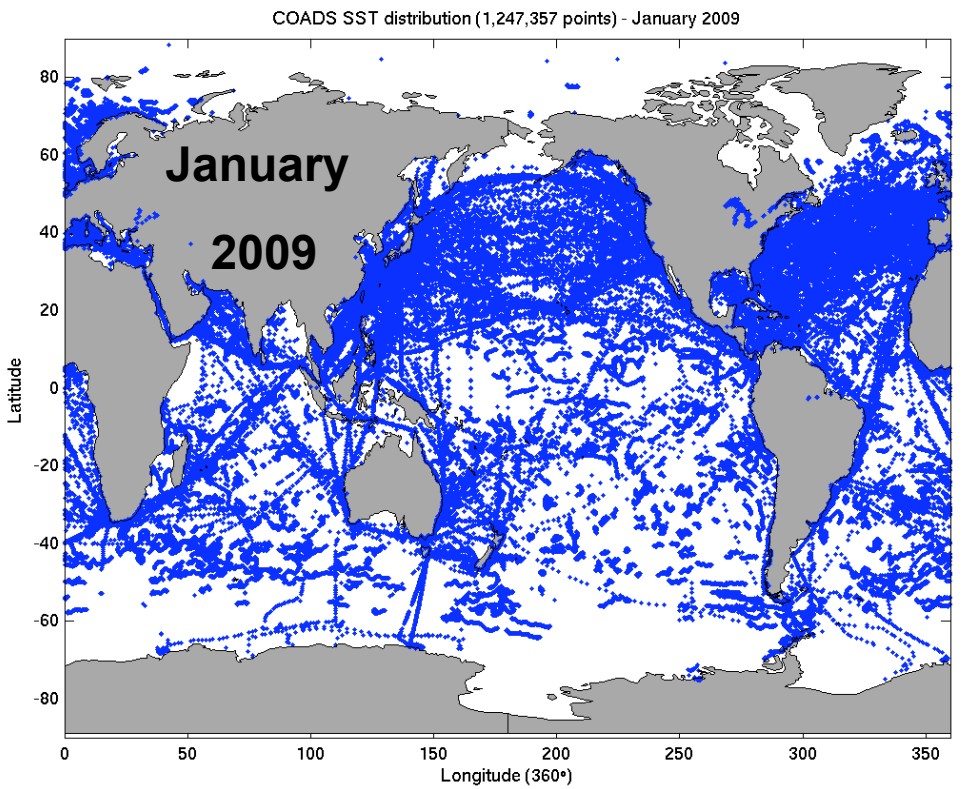
McPhaden et al, 2011

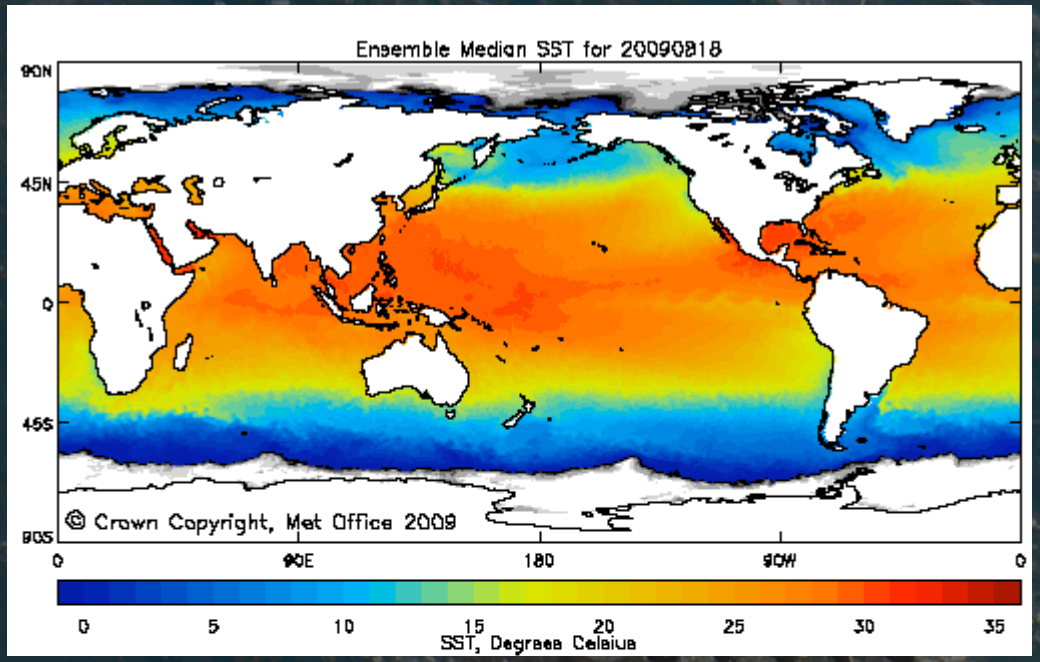
WCRP Open Science 2011

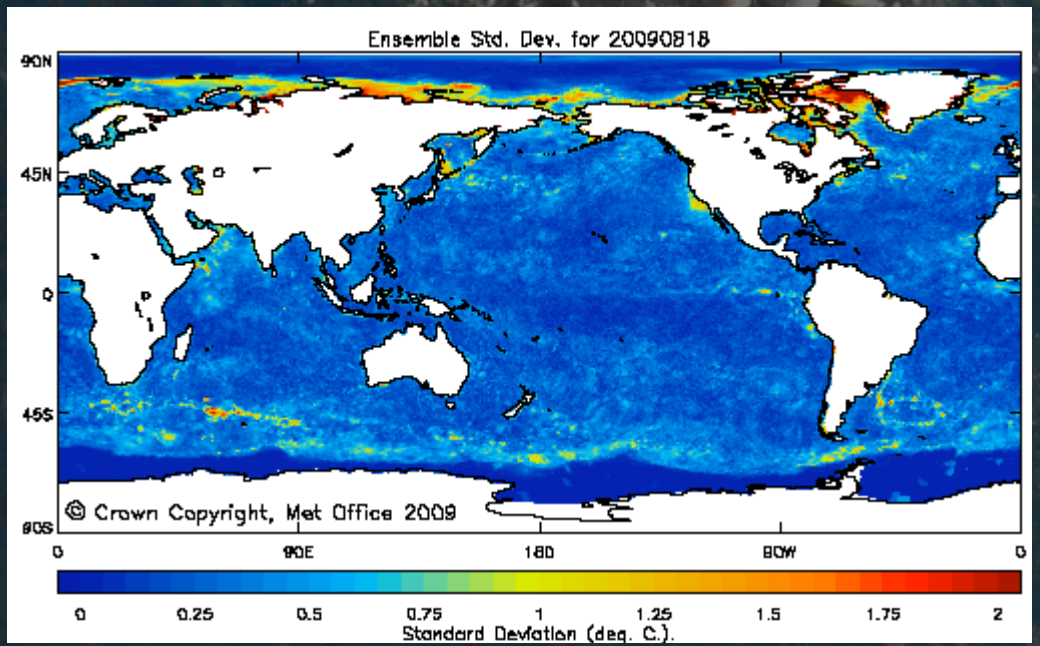
Progress: Steady growth and better global coverage of *in situ* SST returns



- Largely achieved through growth of surface drifter array



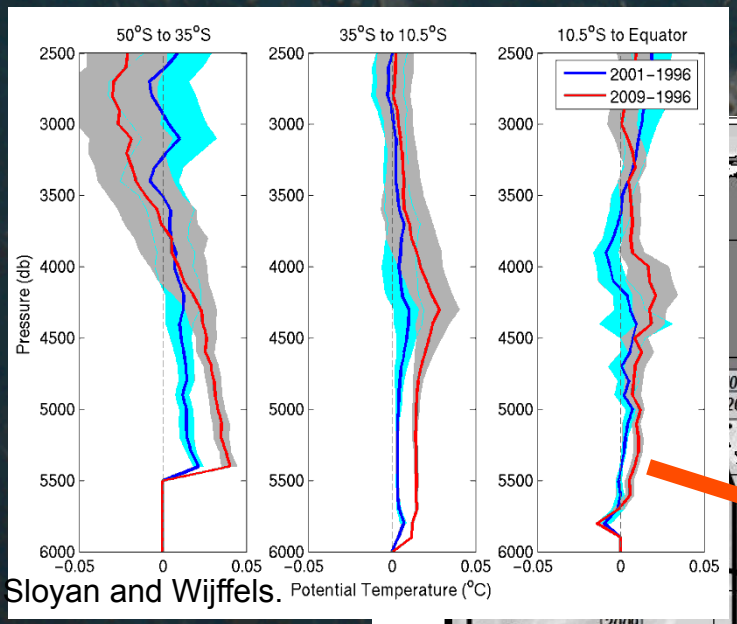




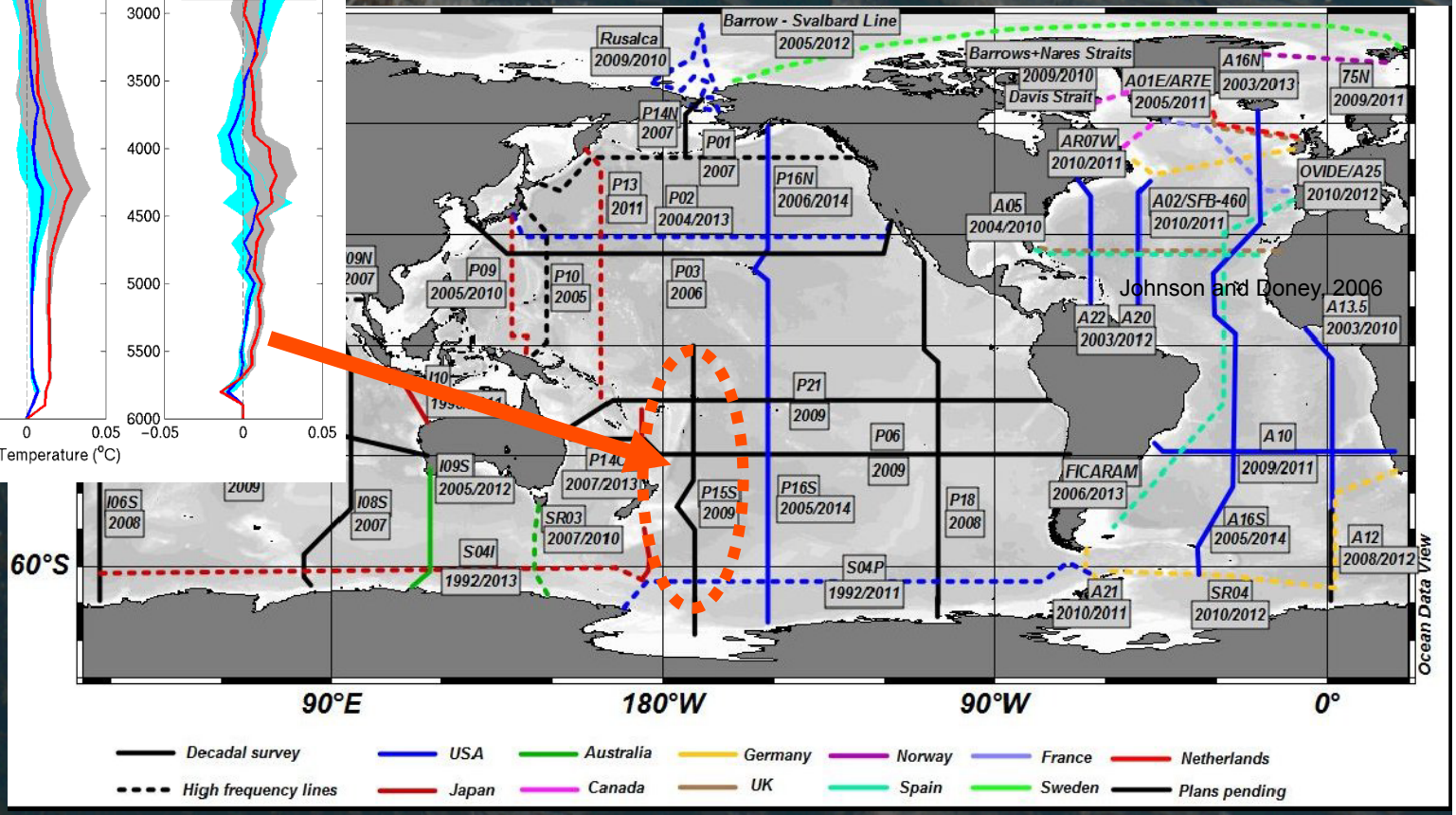
Progress: Global High Resolution-SST Project

- Re-engaging the research community in the science of SST measurement
- Exploiting multi-satellite/ sensor mission
- Community consensus approaches to satellite/*in situ* synthesis and error estimation

Progress: repeat hydrographic program established - GOSHIP



Sloyan and Wijffels.



- Detecting widespread and rapid bottom water warming

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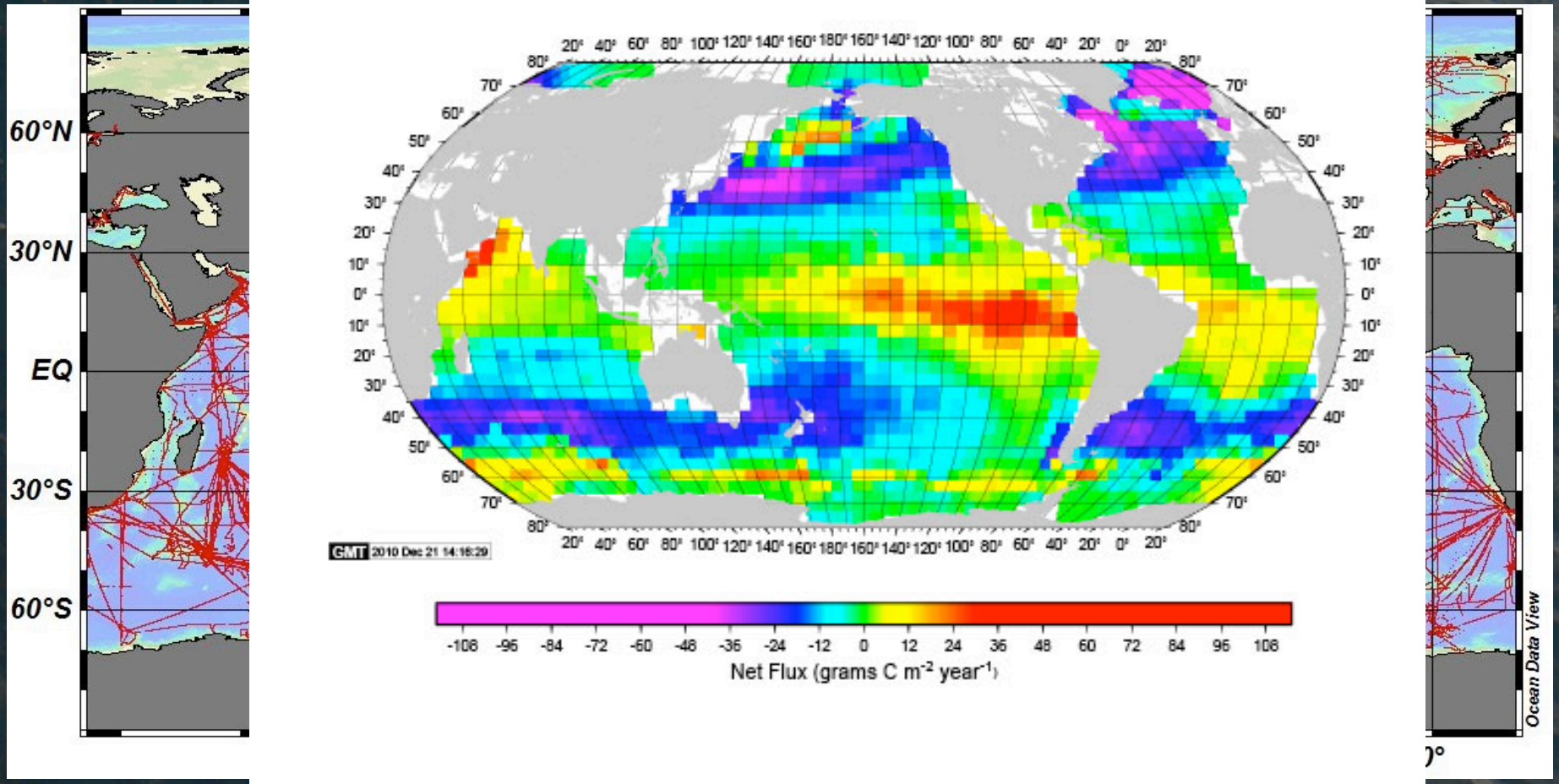
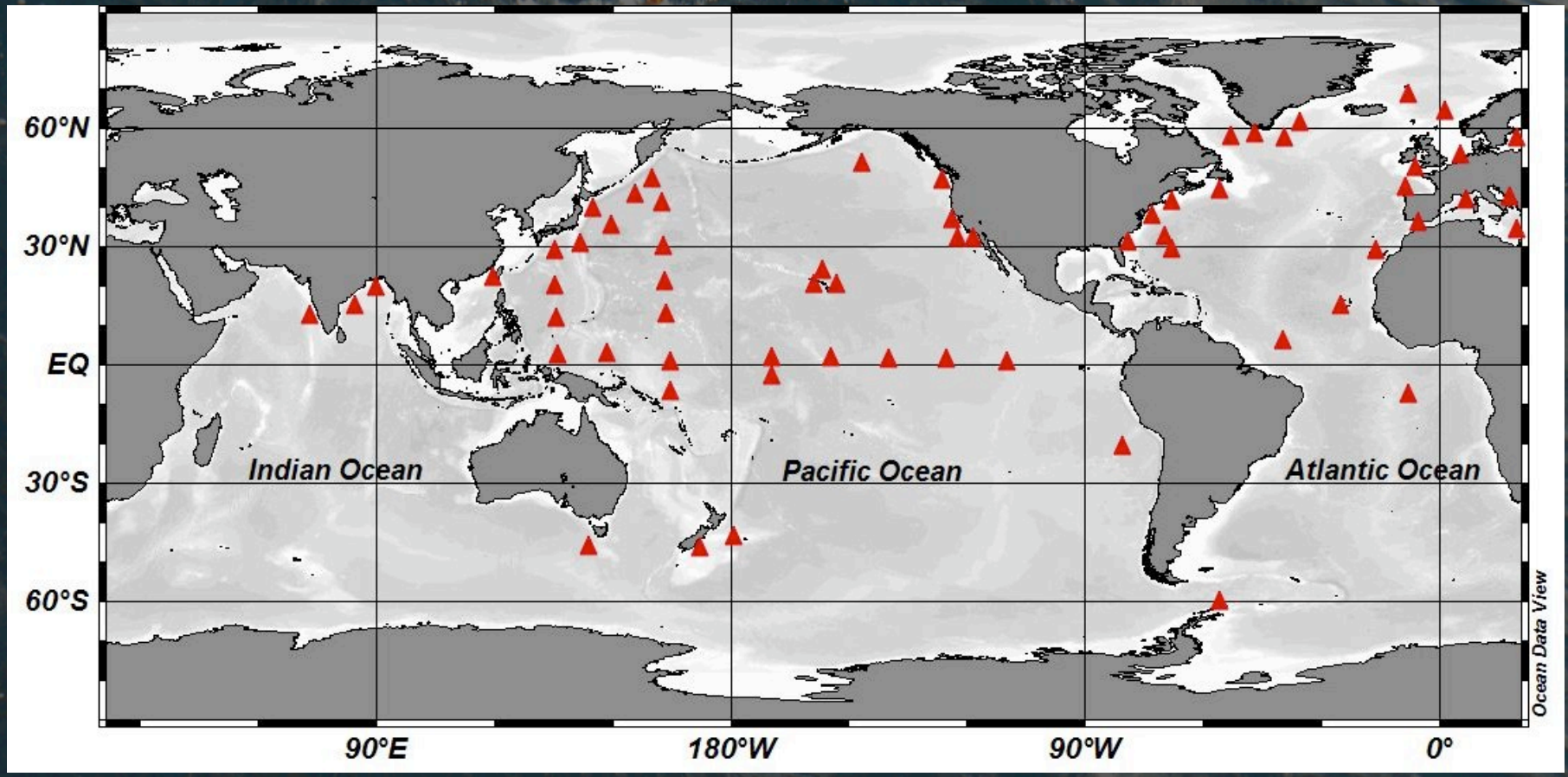
Progress: Surface pCO_2 me

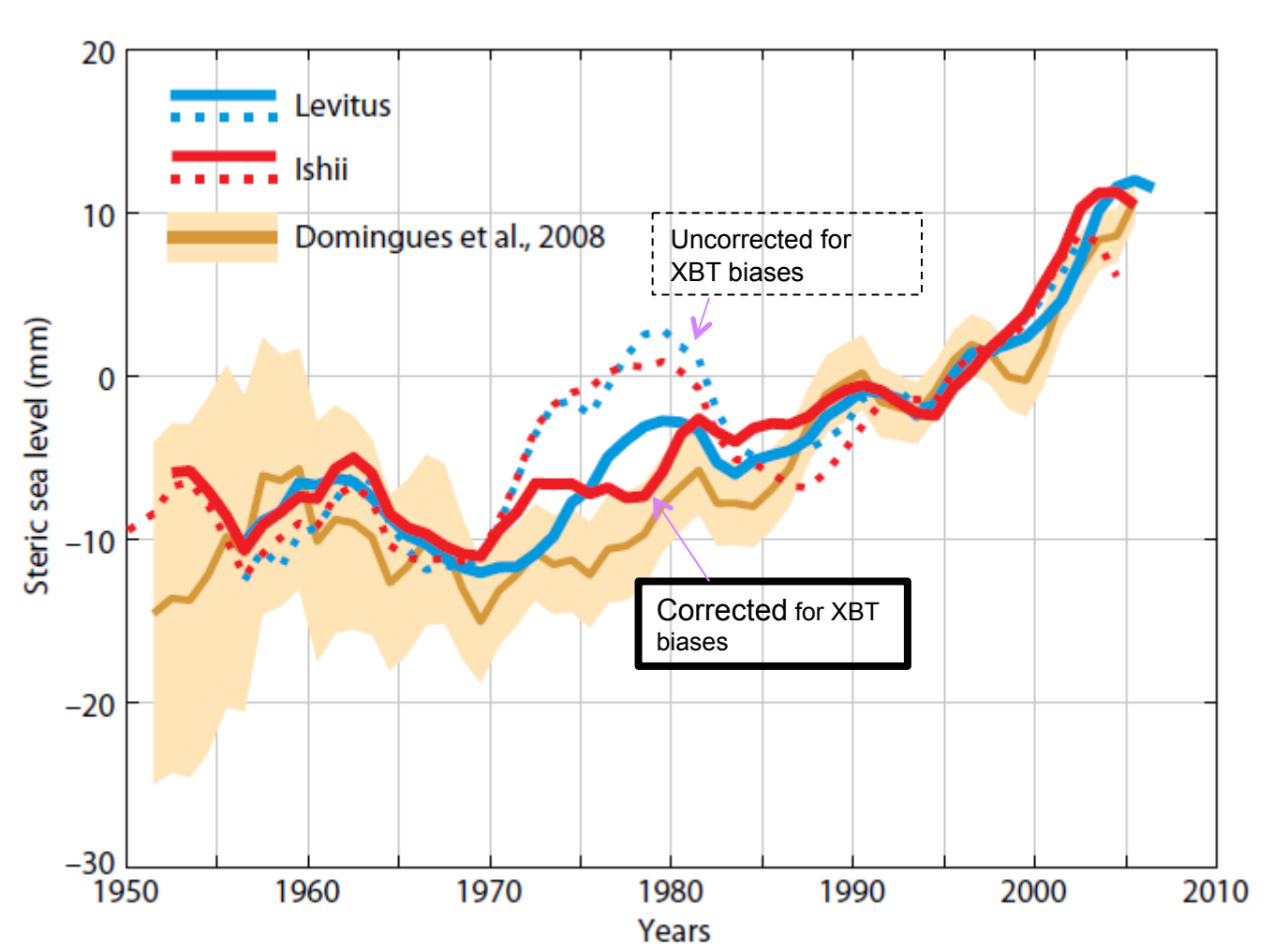


http://cdiac.ornl.gov/oceans/LDEO_Underway_Database/

Progress: Time Series for Ocean Carbon – very sparse network



Retrieving the climate record: tracking down biases in ocean profile data



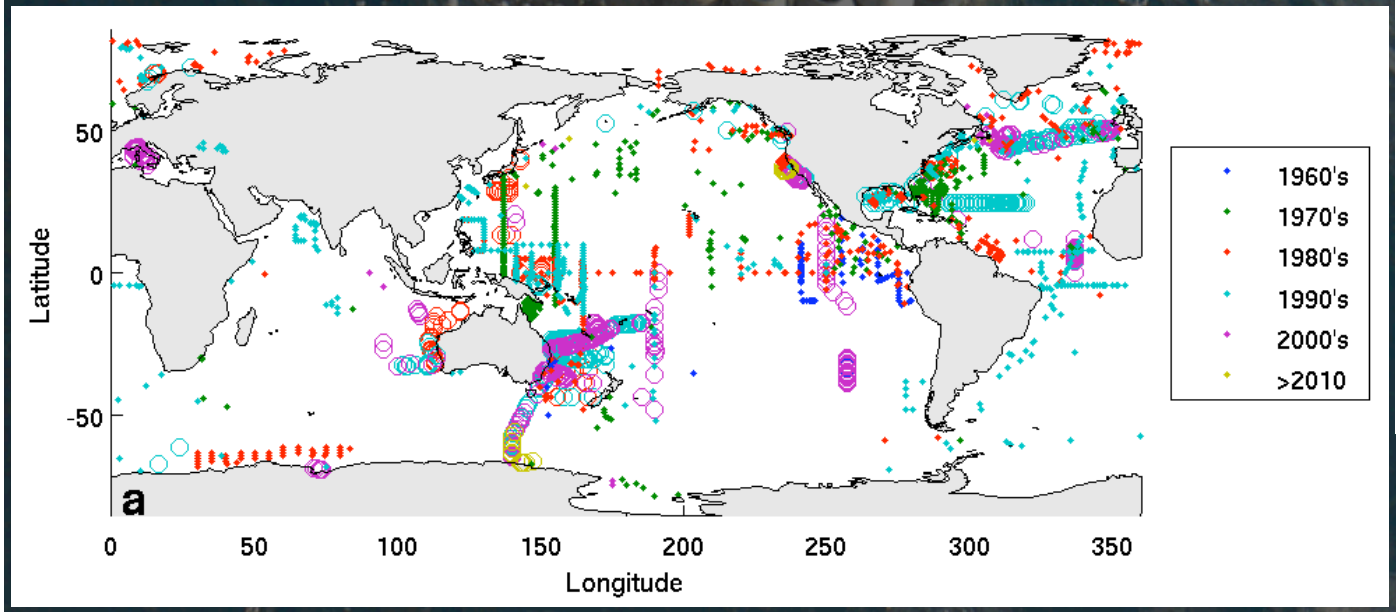
WCRP Open Science 2011

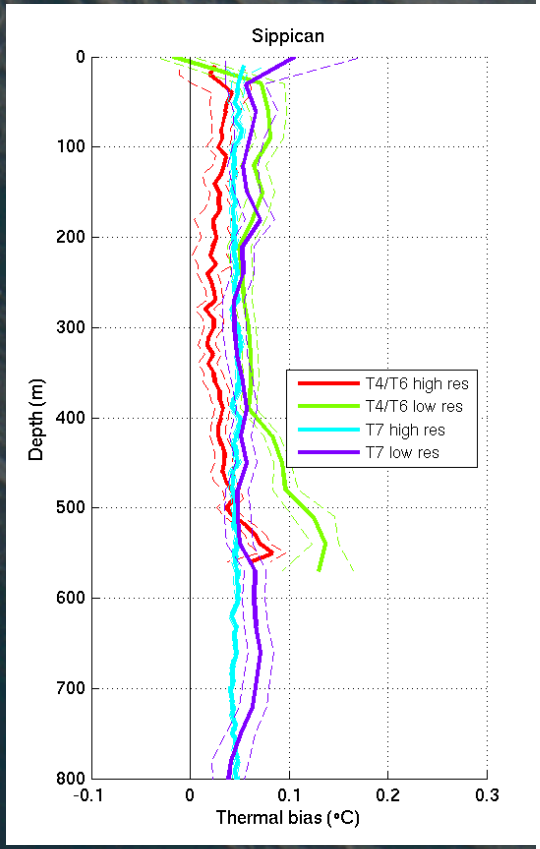
Retrieving the climate record: biases in ocean profile data

Expendable Bathy Thermograph (XBT) data are subject to both thermal and depth biases – now several correction schemes proposed but none appear regionally consistent or agree with each other.

+ co-located pair data set being assembled and analysed

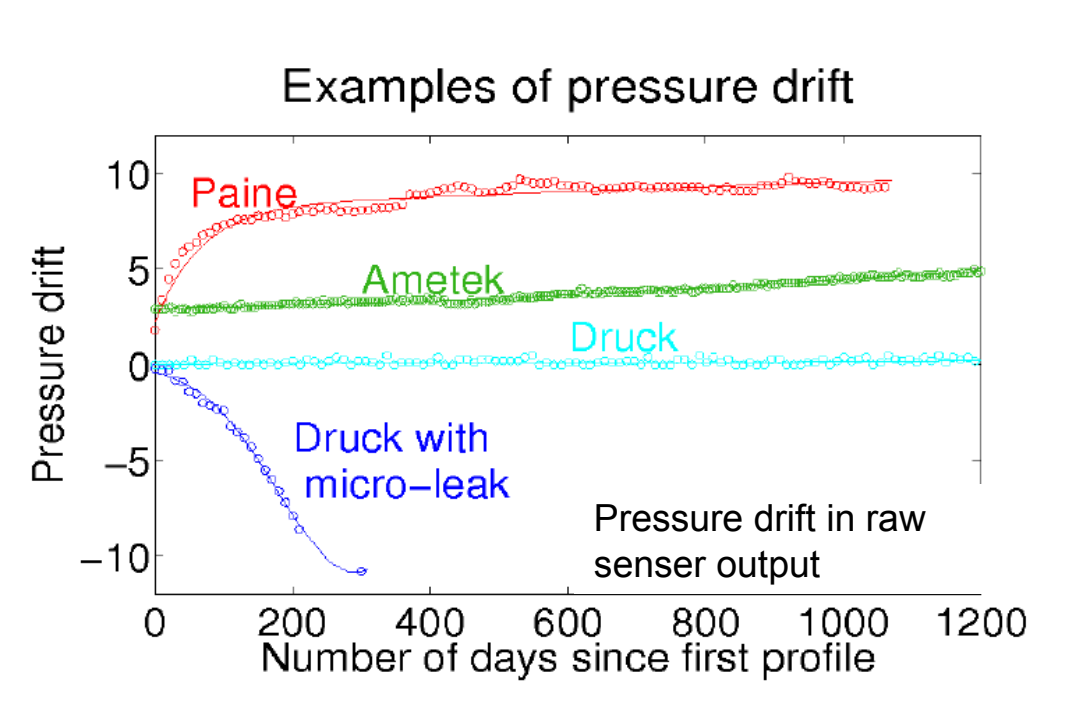
+ need QC problem tackled properly – little progress so far





From Bec Cowley,2011

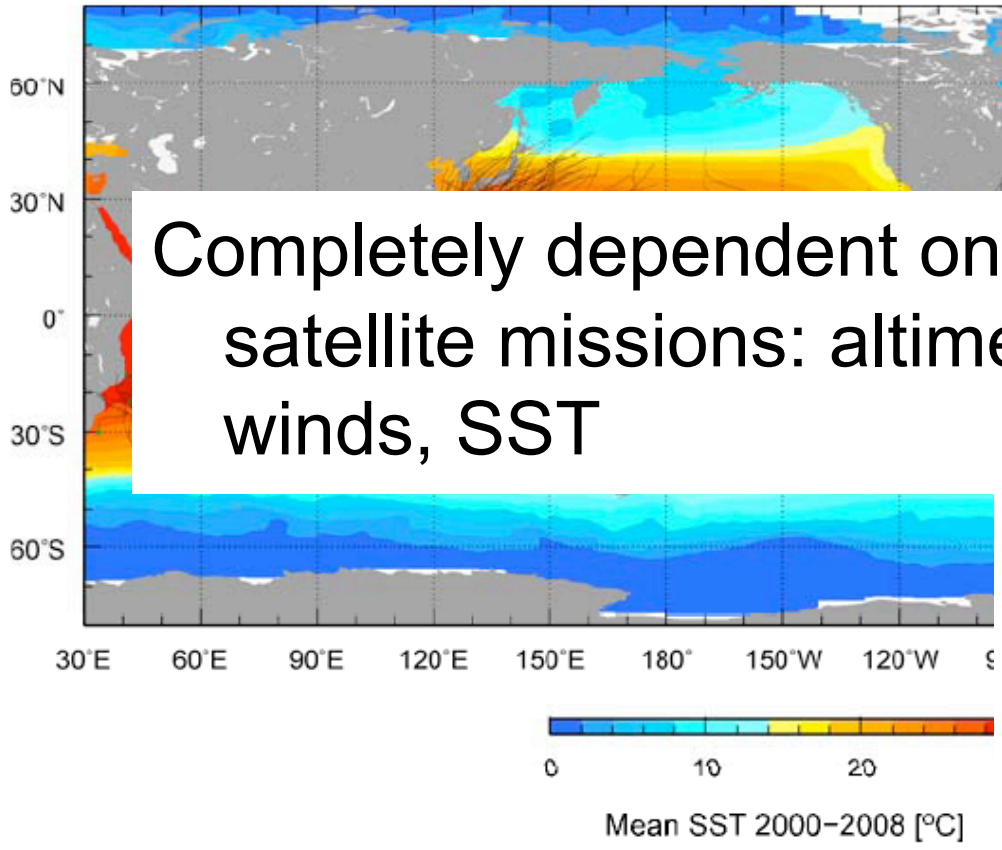
Retrieving the climate record: biases in ocean profile data



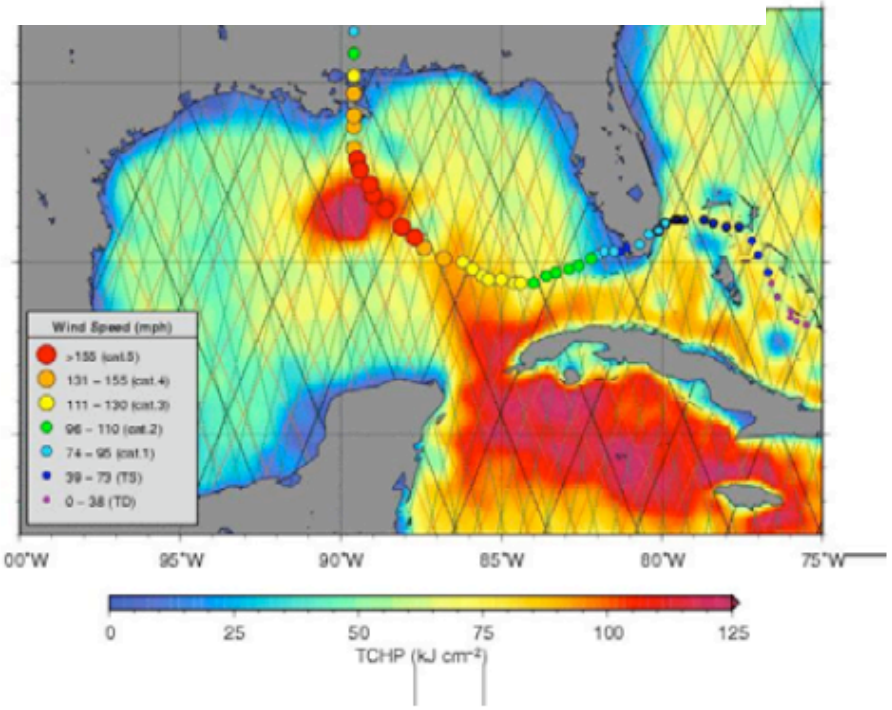
Instrument pressure biases in Argo have now been tracked and removed

Demonstrated of the need to retain key meta-data and track data quality as the system is 'live'

Progress: started to resolve the ocean mesoscale and its impacts on weather and climate



Completely dependent on mesoscale-resolving satellite missions: altimetry, ocean vector winds, SST



Goni et al, 2011

Key Actions: sustain

Can we maintain these advances?

+ use more efficient technologies

+ grow the number of contributing countries

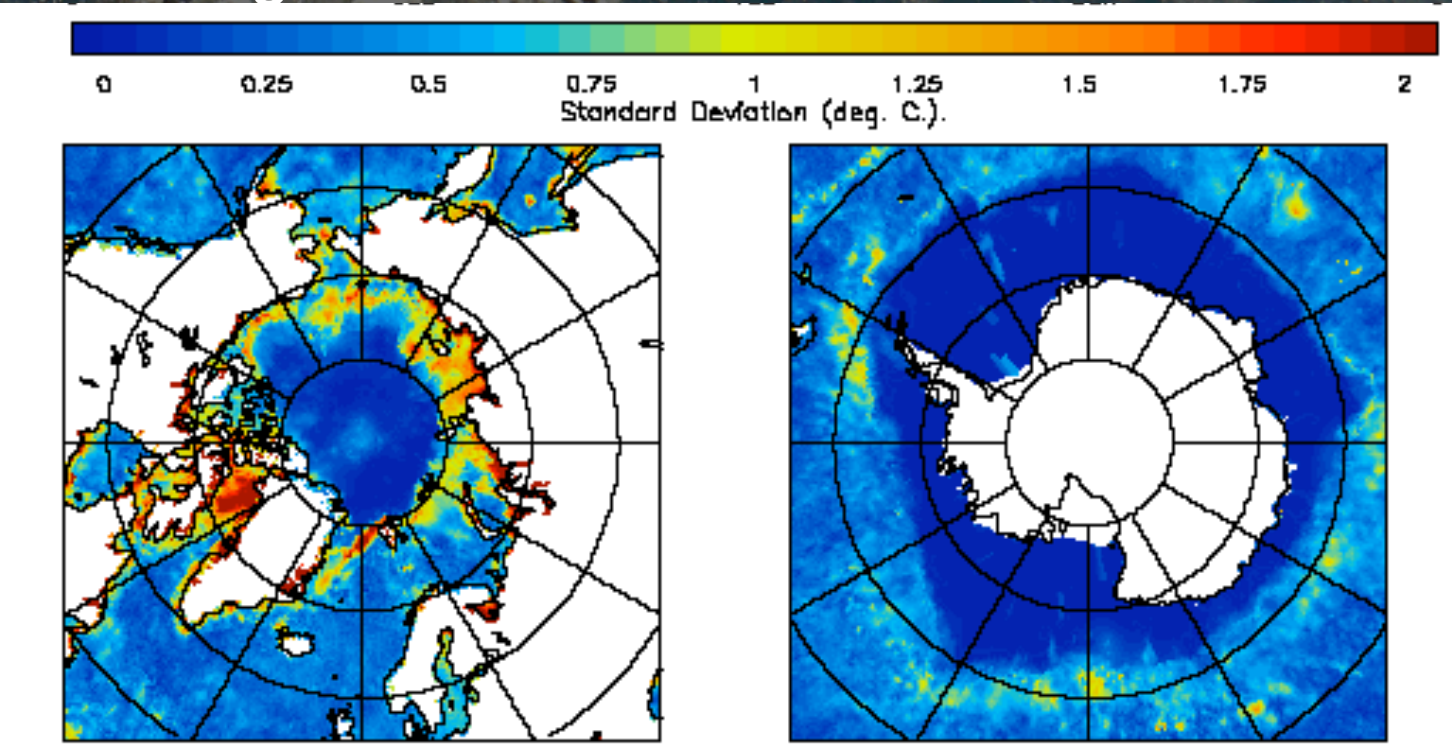
Is their any gross redundancy in the system?

None identified so far – and a little redundancy is needed to ensure robustness and to detect platform biases.

Gaps: seasonal and fast ice zone

- Area of most rapid change
- little subsurface profile data – winter climatology poorly known let alone the variability
- difficulty in using satellite data streams here

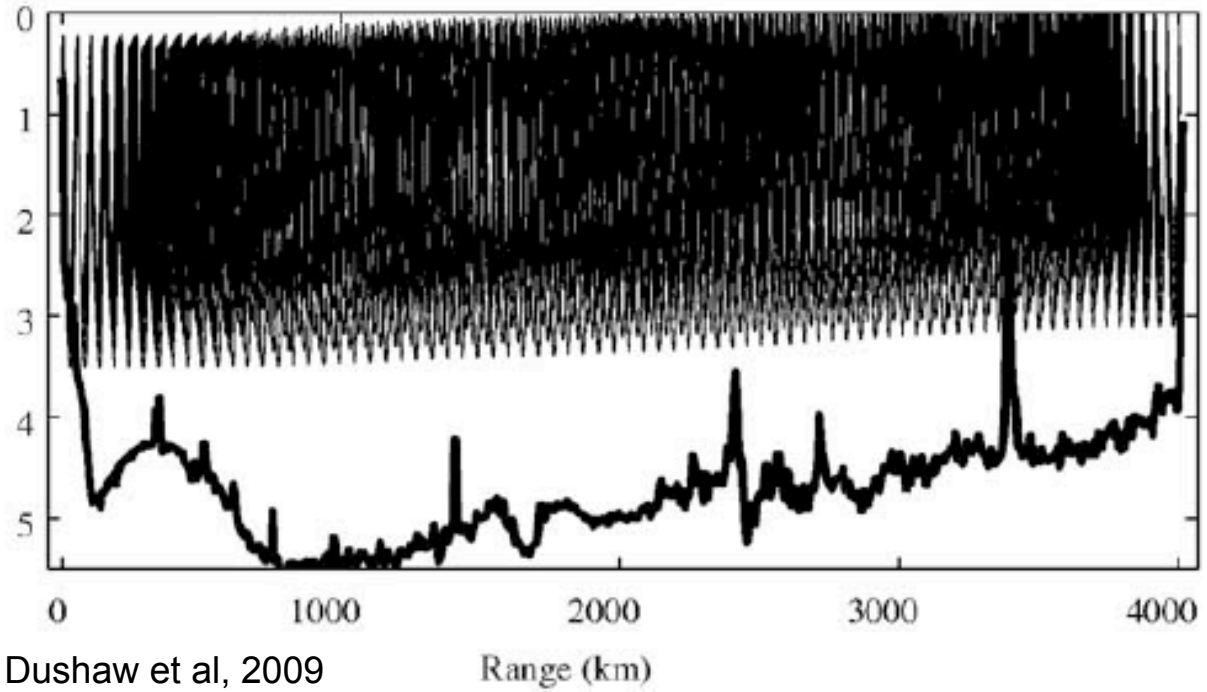
Ice profilers and ice-capable floats present an affordable path forward – many successful pilot deployments



Donlon et al, 2011

Gaps: the deep ocean is changing but is very sparsely monitored

- Develop and pilot **broad-scale deep ocean monitoring** technologies to inform a global future strategy. Optimize the mix of deep moorings, deep profiling floats and gliders, ocean acoustic thermometry



Dushaw et al, 2009

The Future Science Challenges

Decadal Prediction

1. Is Argo enough to initialise these systems? Do we need to go deeper?
2. How do we validate? Likely need decadal records of key element of the global ocean circulation. We need to start measuring now.

Mesoscale coupling of the atmosphere and ocean:

1. Heavy dependence on satellite winds and sea level measurements – need to sustain these capabilities
2. Need mesoscale resolving observations to challenge these systems e.g. gliders, XBT high density lines, moorings
3. Growing recognition of the importance of surface waves – what observations are needed?

The Future Science Challenges

Ocean carbon

Essential for constraining Earth System Models: but we are a far cry from real-time inventory tracking

1. Can other technologies help with a broadscale system e.g. new sensors on floats?
2. How can we better utilise ocean colour in constraining the global carbon cycle?

Climate and anthropogenic impacts on marine ecosystems:

1. Lack a framework for monitoring marine ecosystems – still in 'discovery mode' – exception is plankton monitoring
2. How do we combine the climate and ecosystem needs in a single observing system? Can we track rate and impacts of ocean acidification?

Thanks to the organisers and contributors to OceanObs09

www.oceanobs09.net