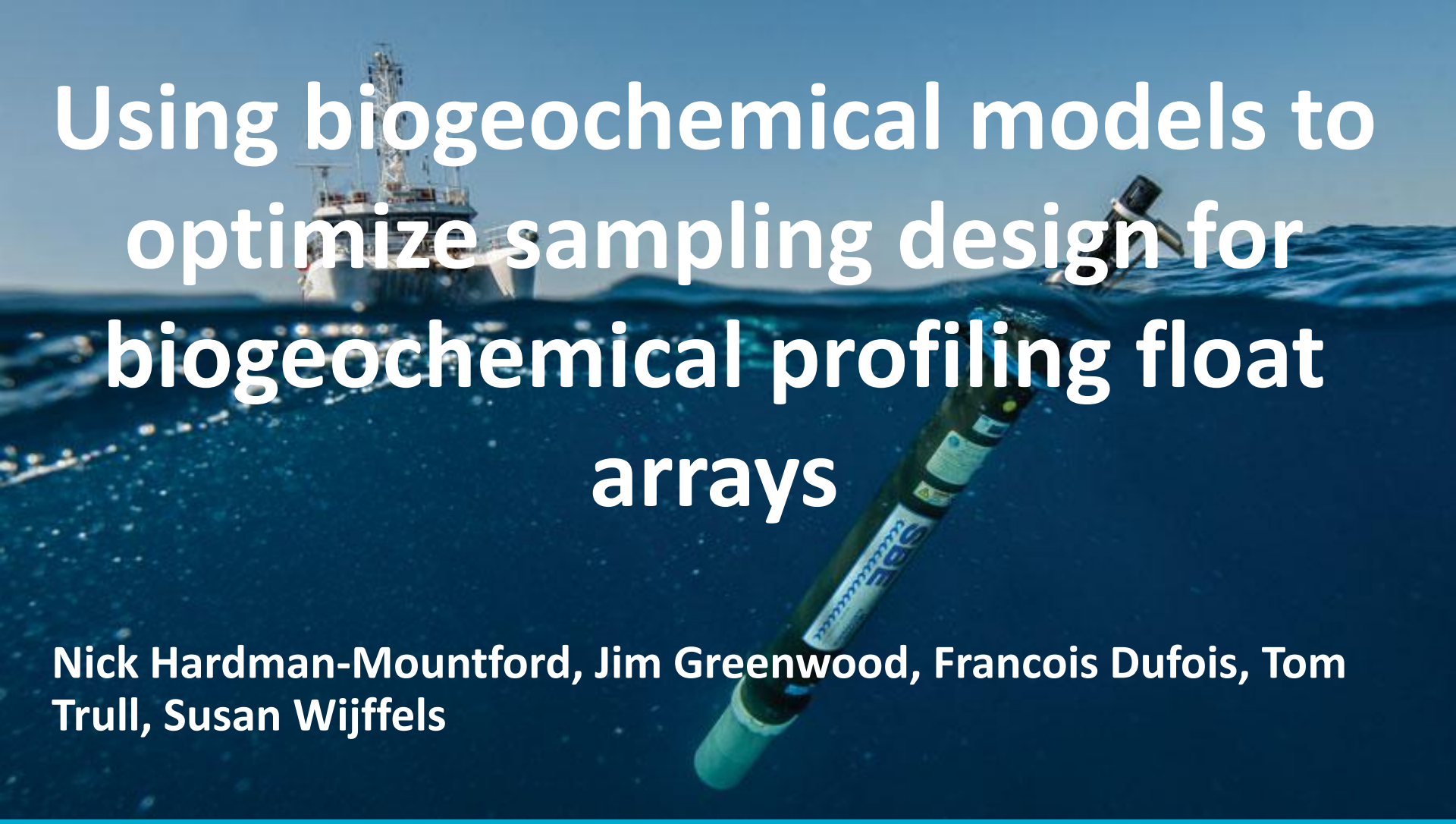
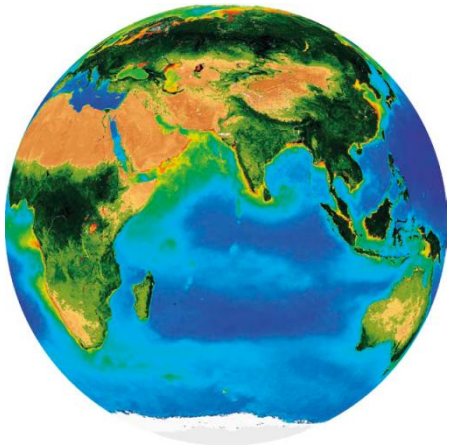
Using biogeochemical models to optimize sampling design for biogeochemical profiling float arrays



Nick Hardman-Mountford, Jim Greenwood, Francois Dufois, Tom Trull, Susan Wijffels

Australia-India Joint Indian Ocean Bio-Argo Project

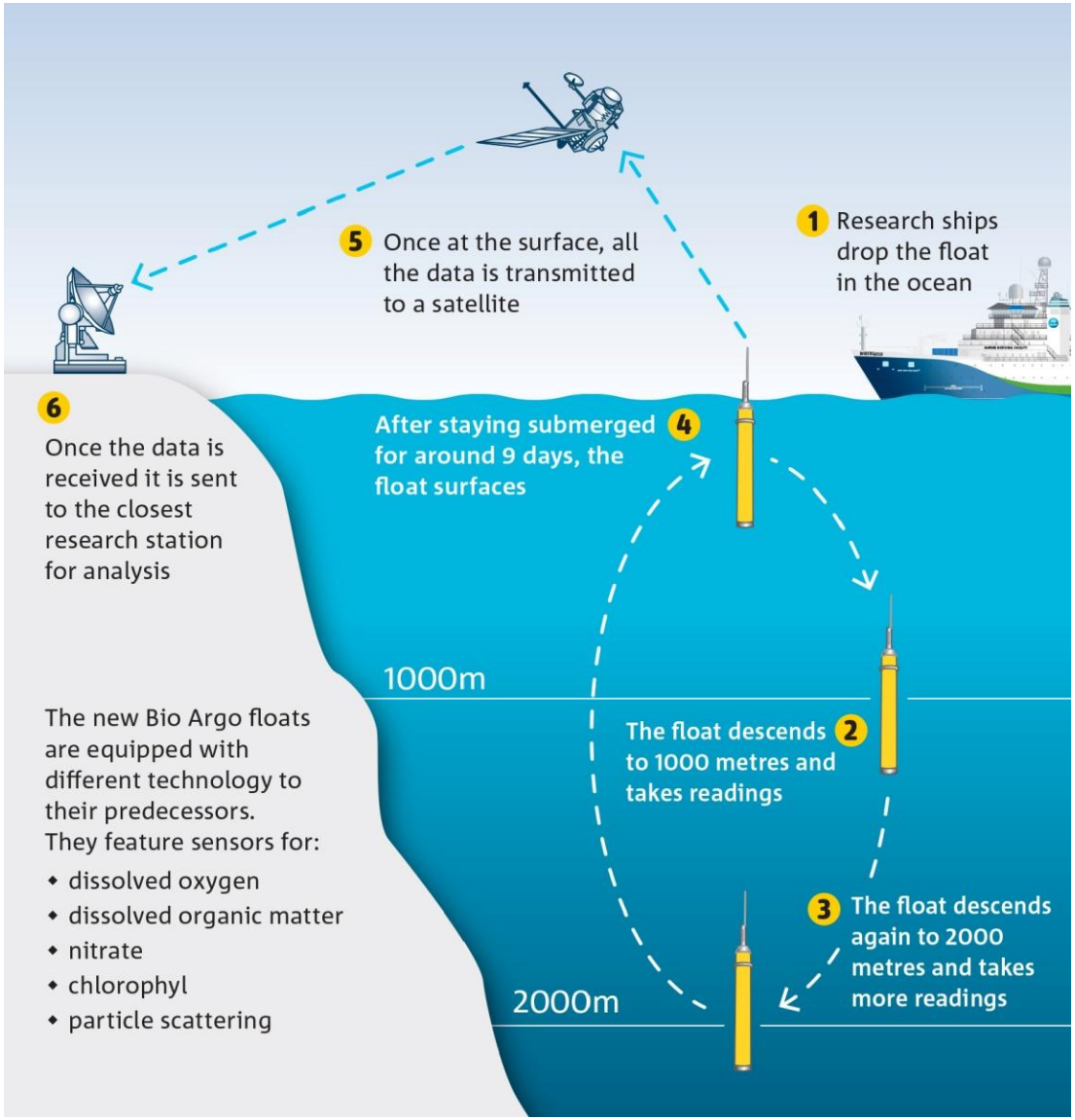
"Characterising the changing Indian Ocean's biogeochemistry and ecology using revolutionary new robotic tools"



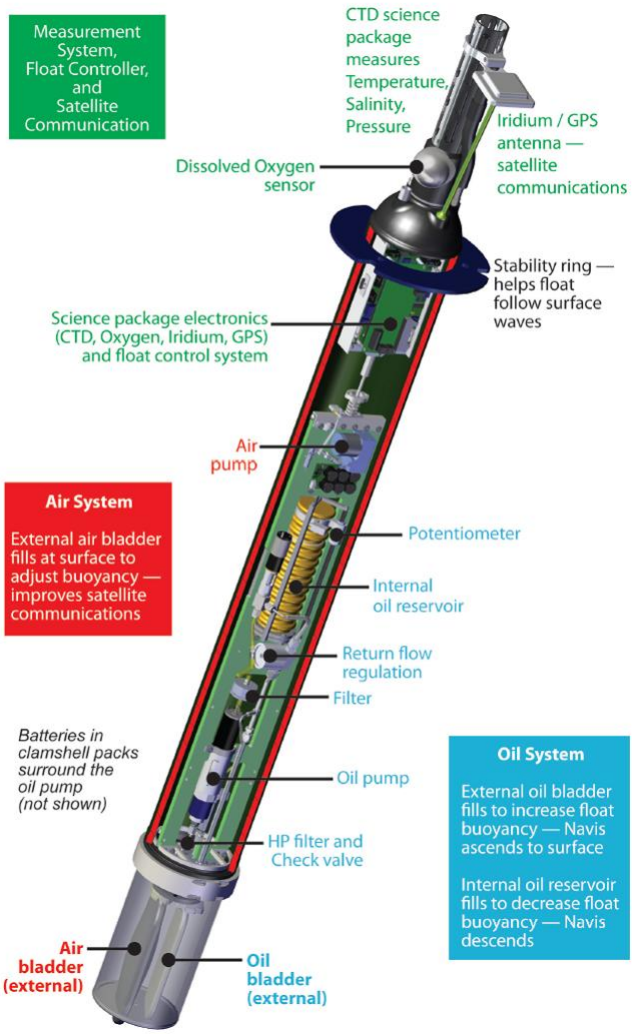
- Collaboration between:
  - CSIRO (Australia): Hardman-Mountford, Trull, Wijffels
  - CSIR-NIO and INCOIS (India): Naqvi, Ravichandran

- Aims:
  - Coordinated bio-float deployments (2014-15)
  - Joint protocol development for deployments and data (with international Bio-Argo community)
  - Facilitate wider collaboration towards Indian Ocean Bio-Argo network

What are Bio-Argo Floats?



What are Bio-Argo Floats?



Float specs:

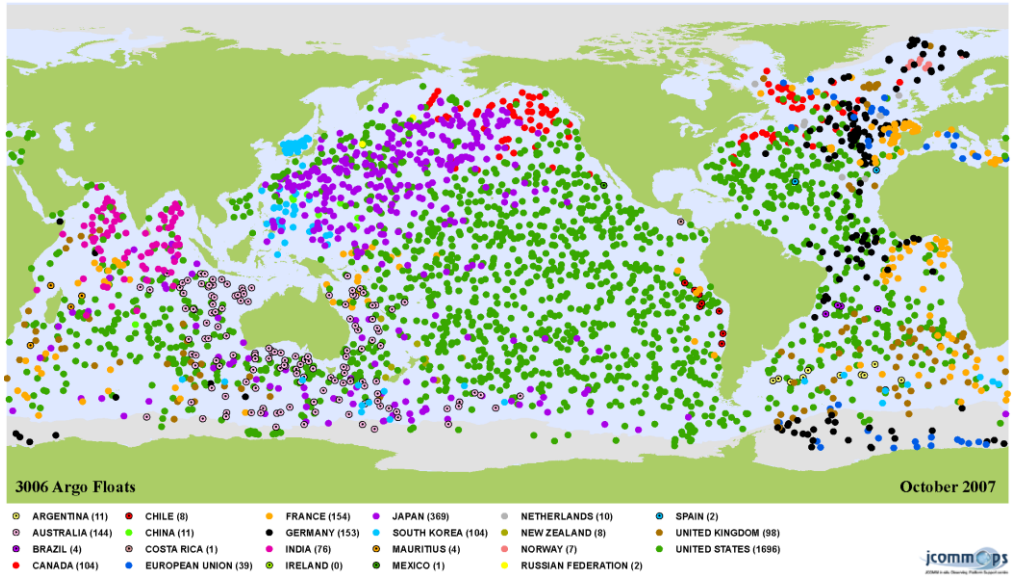
BGC: CTD, DO_2, Chl F, CDOM F*, backscatter (532*, 700 nm), UV NO_3*

Val: as BGC + radiometry (Lu/Ed, 4 wavelengths), transmissometer (650 nm), backscatter (470 nm)

* options – not on all floats

http://www.seabird.com/products/spec_sheets/NAVISBGCIdata.htm

How do Bio-Argo Floats work?



- How to optimise Bio-Float sampling?
  - Profile frequency?
  - Profile depth?
  - Park depth?
  - Float lifespan?
  - Sensors?
- Variable dependent on features of interest

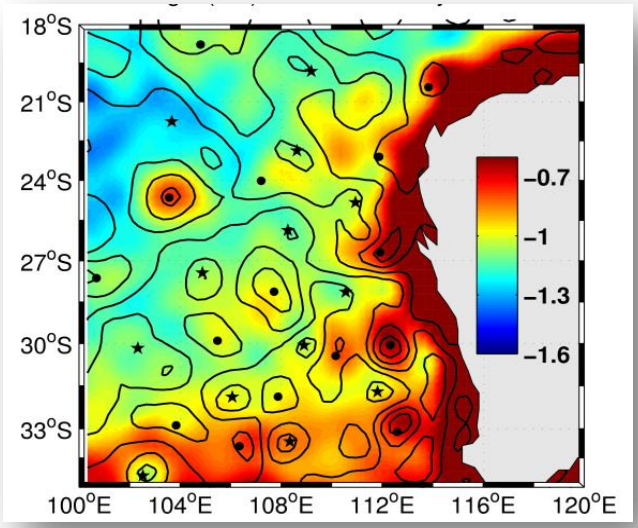
→ Modelling

Why the Indian Ocean?

- Key region for coastal populations
- Ocean biogeochemistry links climate and food security issues

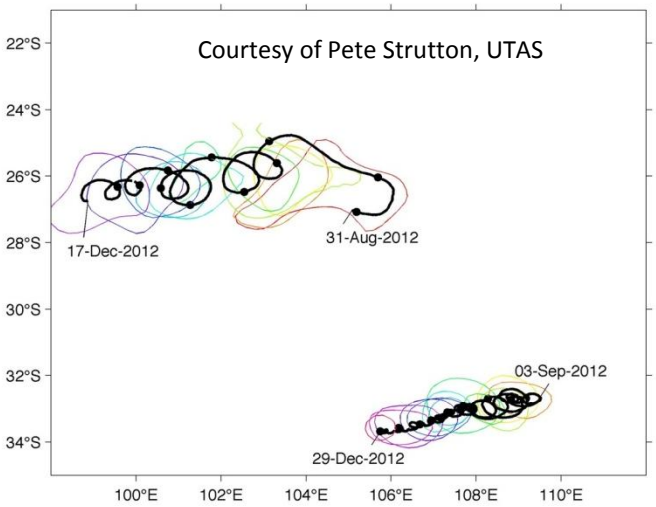
- Key Biogeochemical Features
  - Low oxygen waters: Arabian Sea & Bay of Bengal
  - Productive anticyclonic eddies in SE Indian Ocean
  - Upwelling (Java-Sumatra)
  - Carbon export hotspots (e.g. Kerguelen, Heard Island)
  - …

Chl and SSH



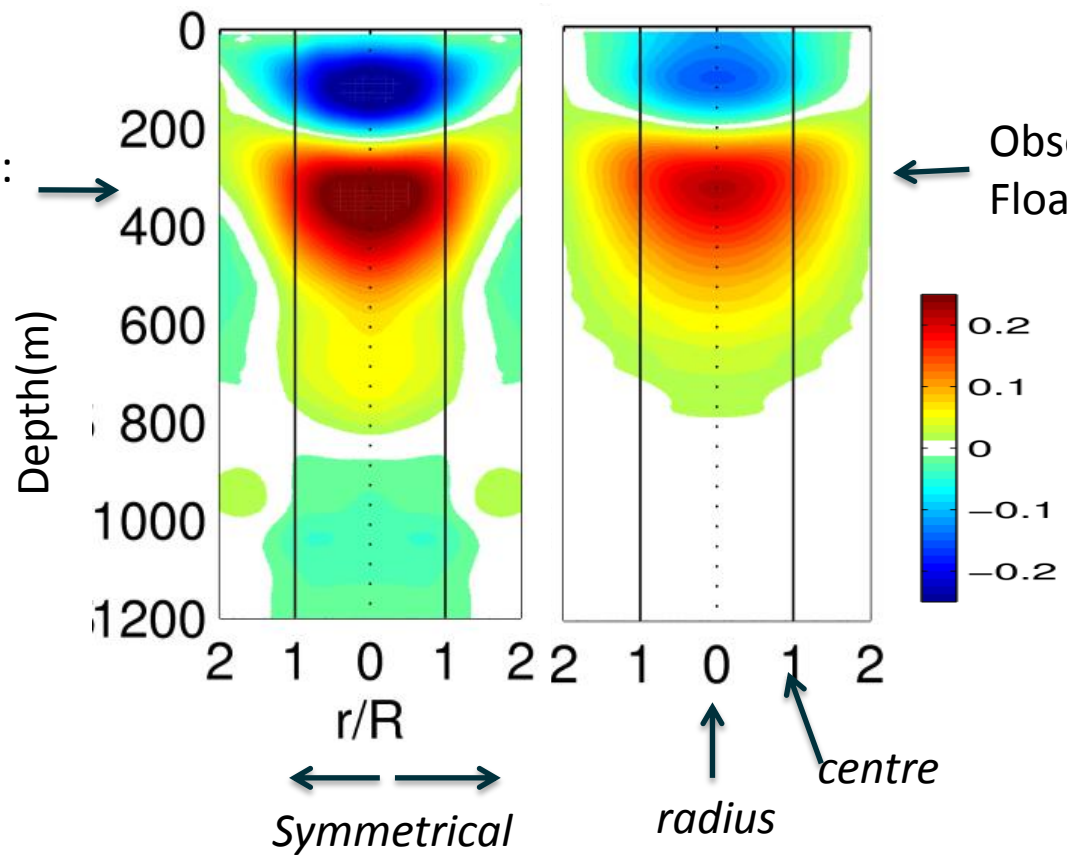
Challenges of using floats to sample AC eddies

- Fundamental questions:
  - Can floats be retained in eddies?
  - Can floats adequately sample eddy structure?



Can floats adequately sample AC eddy structure?

Model (OFAM):
Mean eddy



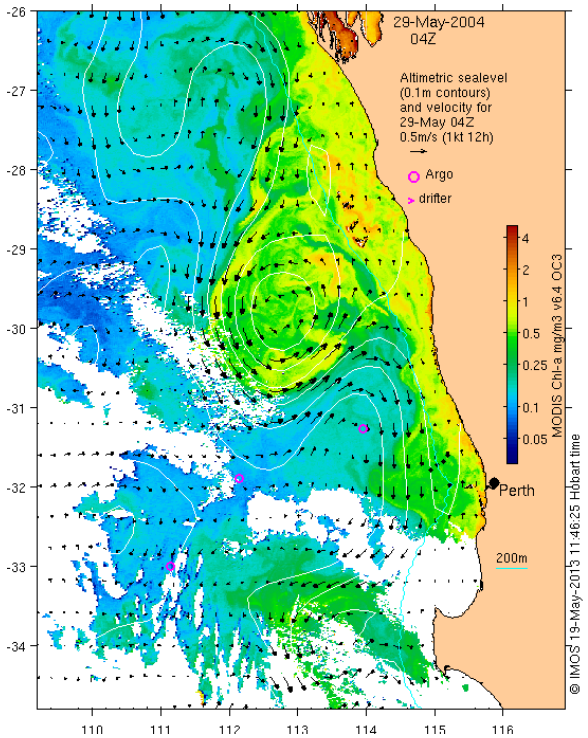
Observations (Argo):
Float-sampled eddy

- Ocean Forecast Assimilation Model (OFAM): global eddy-resolving 10km resolution GCM
- Model compared with observations: mean of 1395 Argo float profiles

→ **'Argo floats ' capture eddy structure**

Challenges of using floats to sample AC eddies

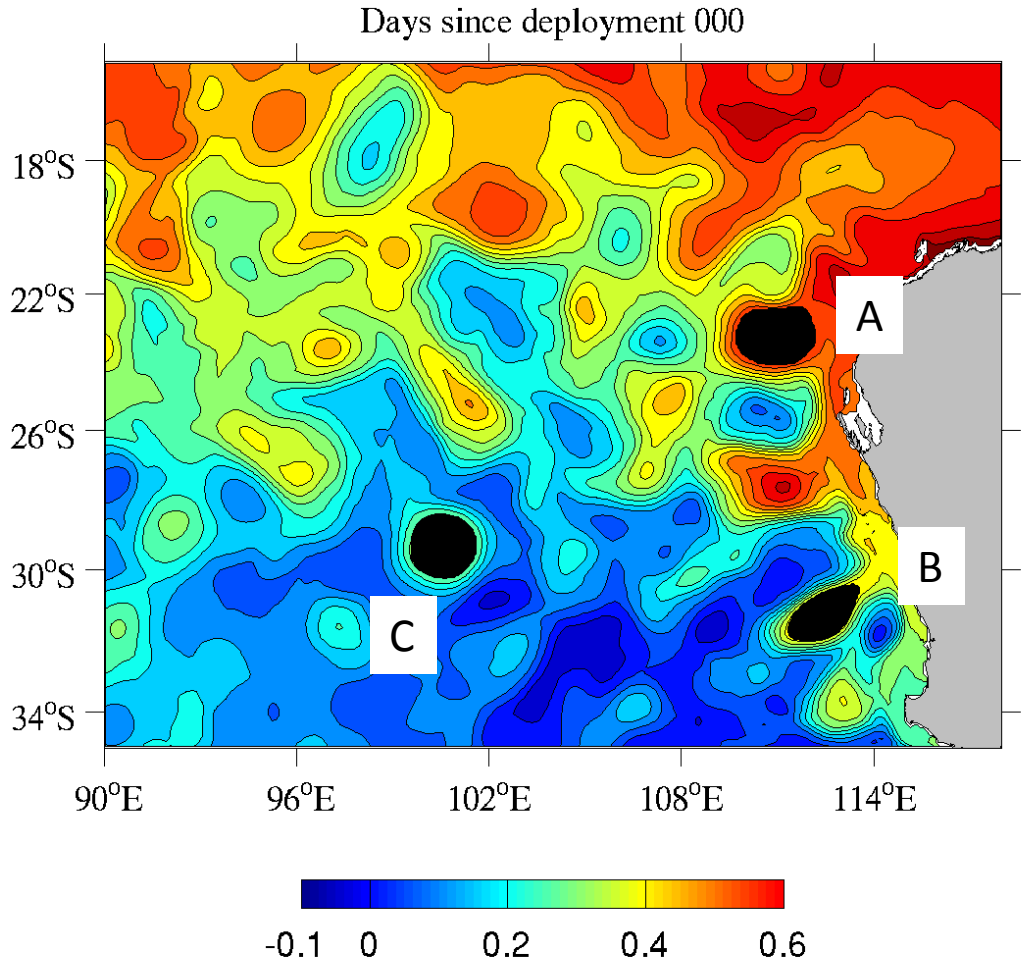
- Fundamental:
  - Can floats be retained in eddies? ✓
  - Can floats adequately sample eddy structure? ✓



➢ Sampling strategy: Optimizing retention

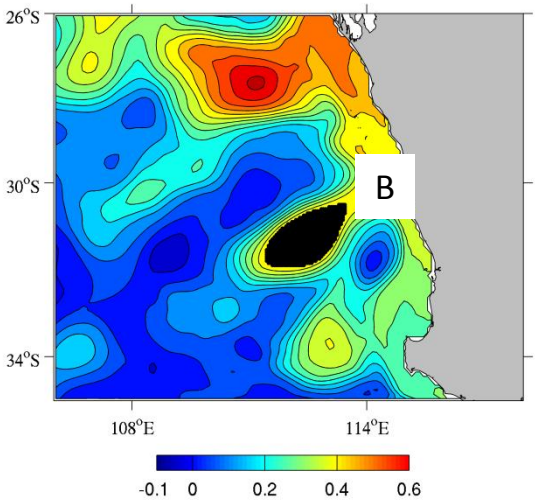
a) Eddy type – forming vs. mature
b) Float location – centre vs. perimeter
c) Profile timing
d) Park depth

Sampling strategy: Eddy Type and float location



- Forming coastal eddies have high loss rate of particles
- Particles close to centre of eddy no more likely to be retained
- Mature offshore eddies have very high retention rate of particles
- Particles in centre have higher rate of retention

Sampling strategy: Profile timing

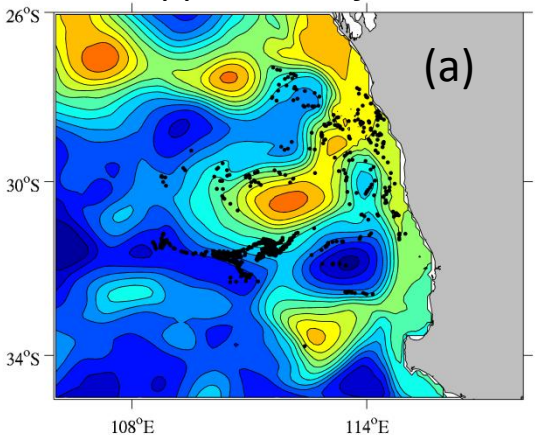


Initial position

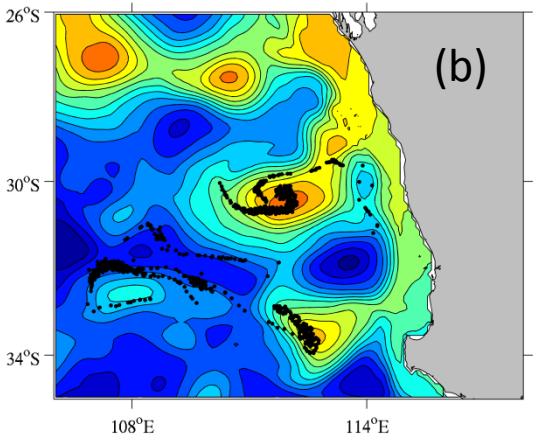
- Floats trapped at surface disperse rapidly
- Extended time at park depth improves retention

Position after 30 days

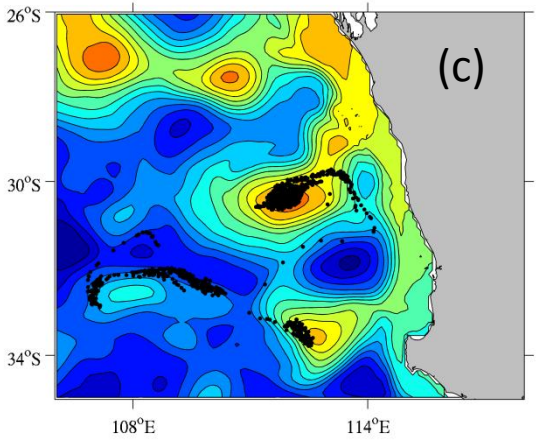
Trapped at surface



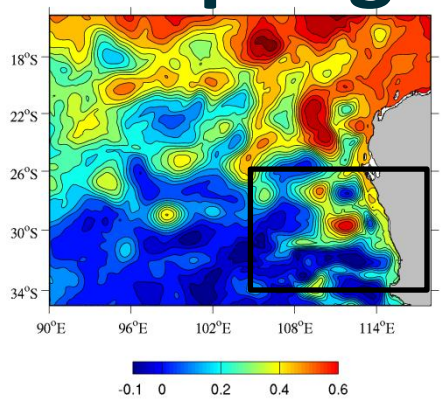
6 hrs between surfacing



12 hrs between surfacing



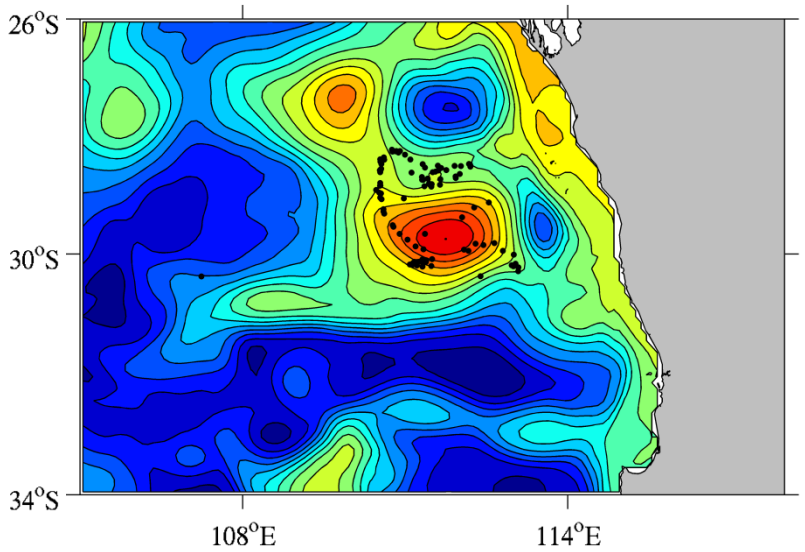
Sampling strategy: park depth



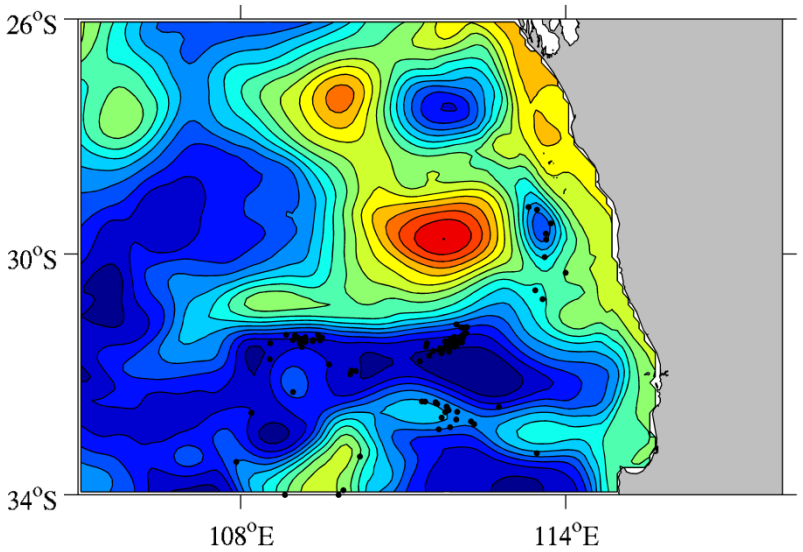
Park depth is critical

Distribution after 60 days

Park depth 300 m



Park depth 500 m



Preliminary conclusions

- Prolonged retention of floats in eddies is possible
- Float sampling can adequately represent eddy physical structure
- Forming (coastal) eddies are relatively unstable and have low rate of retention
- Mature offshore eddies have very high rate of retention and represent the ‘safest bet’ for float deployments in eddies
- In regions of strong horizontal velocities, profile timing makes a difference to retention
- Adjustment of park depth may improve retention in forming eddies
- Some sort of compromise may be needed in the choice of profiling period and park depth to keep floats on the necessary path

Acknowledgements

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