Discussion topics - 1

- Science drivers/regional approach
  - Prioritization necessary
    - Need initial science/regional focus
      - Southern ocean carbon and climate
      - Pacific ocean oxygen minimum zones
      - North Atlantic and coupling of ecosystem to overturning circulation
      - Ocean acidification – now focused on O_2 as a proxy for pH, but likely capable of direct pH observations – region Southern Ocean, margins?

- Cost/Prioritization will define implementation of implementation

Table 5: Estimates of the total 5-year cost of adding oxygen measurements to Argo on a per float basis. Shown are the marginal costs only, i.e. those above the operation of the core Argo program. All costs in the table are given in US$ and all prices are based on typical costs in the US.

Configuration (APEX float)	*O_2 Sensor[a] (i)*	*Sensor Prep.[a] (ii) & (iii)*	*5-Year Comm.[a] (v)*	*Incremental Cost From Reduced Float Lifetime[b] (iv)*	*Data Handling & Control[c] (vi) & (vii)*	*Total Estimated Cost Per Float*	*Change In Cost Relative To T/S[d]*
ARGOS/Optode	3800	400	500	1800	1000	7500	+47%
ARGOS/IDO	2800	100	500	4800	1000	9200	+58%
Iridium/Optode	3800	400	70	1800	1000	7070	+40%
Iridium/IDO	2800	100	470	2200	1000	6570	+37%

THE ARGO-OXYGEN PROGRAM

ARGO O_2

A white paper to promote the addition of oxygen sensors to the international Argo float program

Nicolas Gruber[1] (chair), Scott C. Doney[2], Steven R. Emerson[3], Denis Gilbert[4], Taiyo Kobayashi[5], Arne Körtzinger[6], Gregory C. Johnson[7], Kenneth S. Johnson[8], Stephen C. Riser[3], and Osvaldo Ulloa[9]

What would it cost? First some background:

- US Deep-Sea Drilling Program was order of $55 million/year
- Academic research fleet order of $80 million/year
- Ocean Observatory Initiative (OOI) $300 million/20 year life = $15 million/year.
- Ocean color satellites – order of $500 million/10 year lifetime = $50 million/year.

Using Argo as an example, but there may be other models.

	US Share per year	Total Cost per year
Argo T/S array	$10 Million	$20 Million
Add O_2 to Argo (Gruber et al. 2007) $7070/float	$2.5 M (350 floats/y)	$5 M (700 floats/y)
Add Biooptics (sensor cost 1.75 x O_2)	$4.4 M	$8.8 M
Add Nitrate (sensor 3x O_2)	$7.5 M	$15 M
Add pH (1 x O_2)	$2.5 M	$5 M
Total cost	$27 Million	$54 Million

These numbers are completely scaleable.

Using Argo as an example, but there may be other models.

	One Ocean Basin (/7)	The World per year
Argo T/S array	$2.7 Million	$20 Million
Add O_2 to Argo (Gruber et al. 2007) $7070/float	$0.8 M (350 floats/y)	$5 M (700 floats/y)
Add Biooptics (sensor cost 1.75 x O_2)	$1.3 M	$8.8 M
Add Nitrate (sensor 3x O_2)	$2.2 M	$15 M
Add pH (1 x O_2)	$0.8 M	$5 M
Total cost	$7.7 Million	$54 Million

These numbers are completely scaleable.

Discussion topics - 2

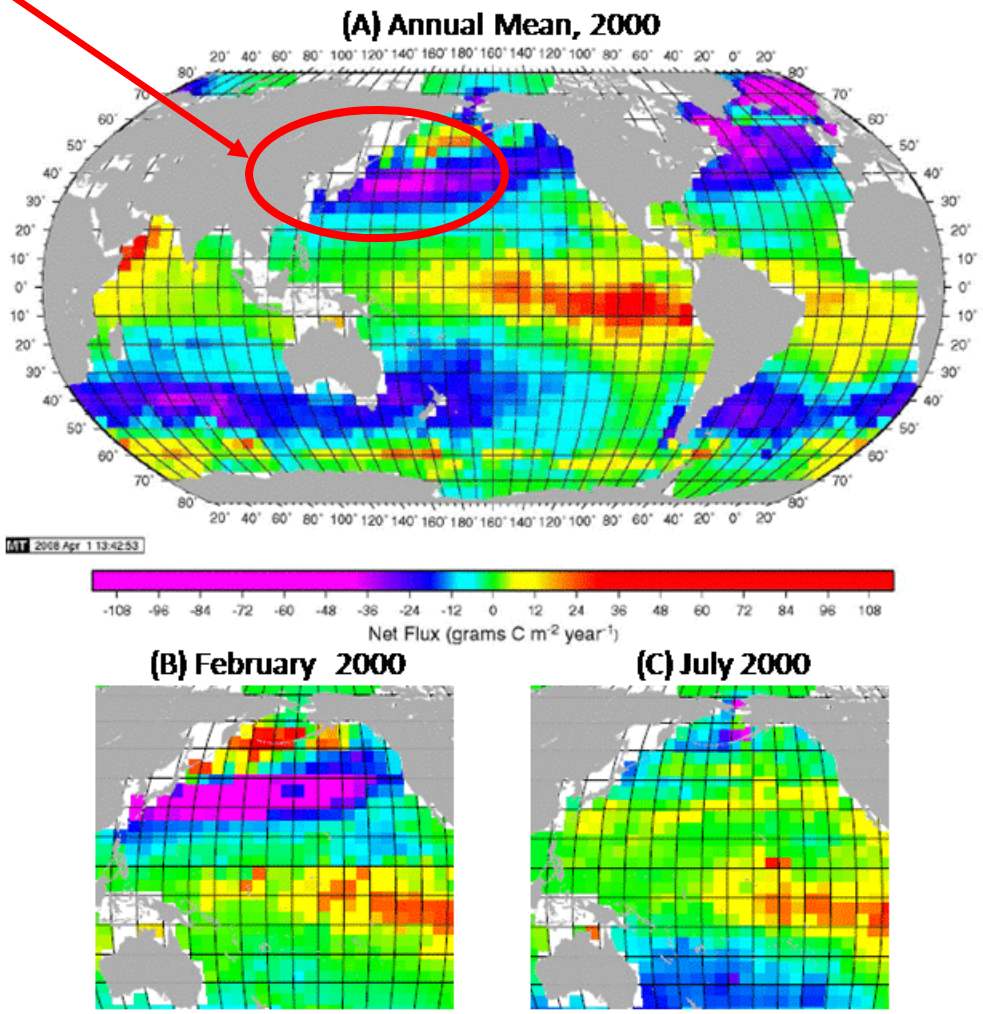
- Science community involvement/comment
  - e-mail input (V. Lance, A. Subramaniam, ...)

- Agency drivers
  - How to entrain agencies in a era of declining budgets

- Organizational model.
  - Interaction with Argo
  - Data access – must be the Argo model
  - Data center essential – Argo, BCO-DMO???
  - Quality control/validation
  - GLOBE provides in situ observations/data center, every thing else comes from the bottom up – models, analysis, science...

- Outreach

Emerson/Riser regional project in NW Pacific – controls on seasonal CO_2 drawdown using O_2 floats



A proposal for a Southern Ocean observing system using profiling floats for long-term observations and gliders for process studies.

J. Sarmiento, L. Talley, J. Russell, H. Cullen, et al.

Despite the crucial role of the Southern Ocean in the Earth System suggested by these hypotheses, the *model studies underlying many of these results are highly controversial*, in part because the models that have been used are too coarse to resolve critical features of the ocean circulation, particularly mesoscale eddies and fronts, and in part because we have only limited observations to test the models due to the great difficulty of obtaining observations in this region.

The oceanographic community is on the cusp of two revolutions that will enable us to test these model-based hypotheses for the first time: (1) The development of a new set of biogeochemical sensors mounted on autonomous floats that sample from the surface to 2000 m and penetrate under ice-covered

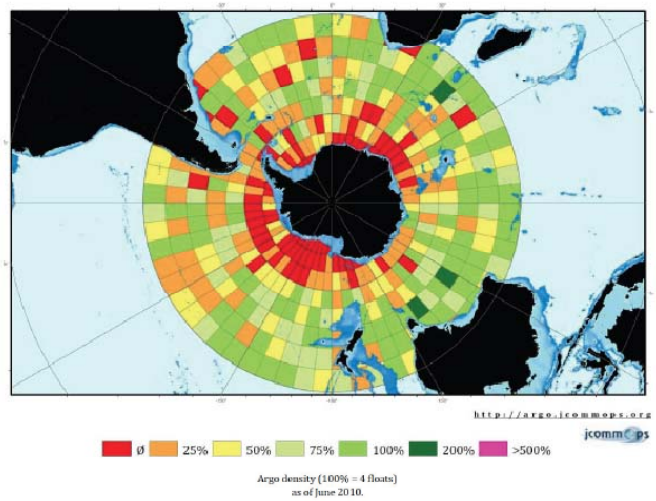


Figure 21: *The status of the Argo array in the Southern Ocean, as of July 2010. Blue colour indicates 0-2000 depth contour. Despite the progress in recent years, large regions of the high-latitude Southern Ocean remain poorly observed, especially close to the Antarctic continent. Courtesy of Mathieu Belbeoch, JCOMMOPS.*

Open ocean alone? Include shelves?

- Argo can ignore the coastal zone because relatively little heat is held in the shallow, coastal ocean. That is not true for the carbon cycle. ~50% of net community production occurs on shelf/slope.
- An open ocean observing system would likely be dominated by floats.
- A coastal ocean observing system would likely be dominated by gliders.
- Significant issues with trying to do coastal ocean, because of EEZ and operational complications (gliders need servicing, floats don't).

Comments from community

Veronica Lance – high latitude/optics...

Ajit Subramaniam

I deployed Pogo I in the Amazon River plume in June of last year and
where I had it bounce once a day to 1000m. We got about 10 days of data
before the Eco triplet connector malfunctioned. I continued to collected CTD data over the next 20 days.

I deployed Pogo II and Bobo I in the Gulf of Mexico last year. Bobo was
deployed on the 22nd Aug and recovered on the 21st Dec. Pogo was
deployed on the 28th Aug and lost at sea on the 8th of November (because
it was not picked up in time and ran out of juice). These two
deployments were to track the oil that was released into the Gulf

Floats or Gliders?

R. Davis presentation at 2009 OCB Float/Glider Workshop

1. **Gliders provide spatial structure (slowly) and simplify recovery**
2. **Glider measurements can (to some extent) be positioned**
3. **Floats provide (very approximate) Lagrangian time series**
4. **Floats are less expensive (purchase 15K$ vs 90K$)**
5. **Floats are much easier to adapt (more batteries, big sensors)**
6. **Floats are relatively immune to fouling – better for long duration**

Map with L/T (of signal) > 25 cm/s (ocean basin/month): array of floats

Map with L/T < 25 cm/s (cont. shelf/month): glider(s)

Quasi-Lagrangian time series: floats

Many big co-located sensors: floats