Lessons from Argo and Future Capabilities

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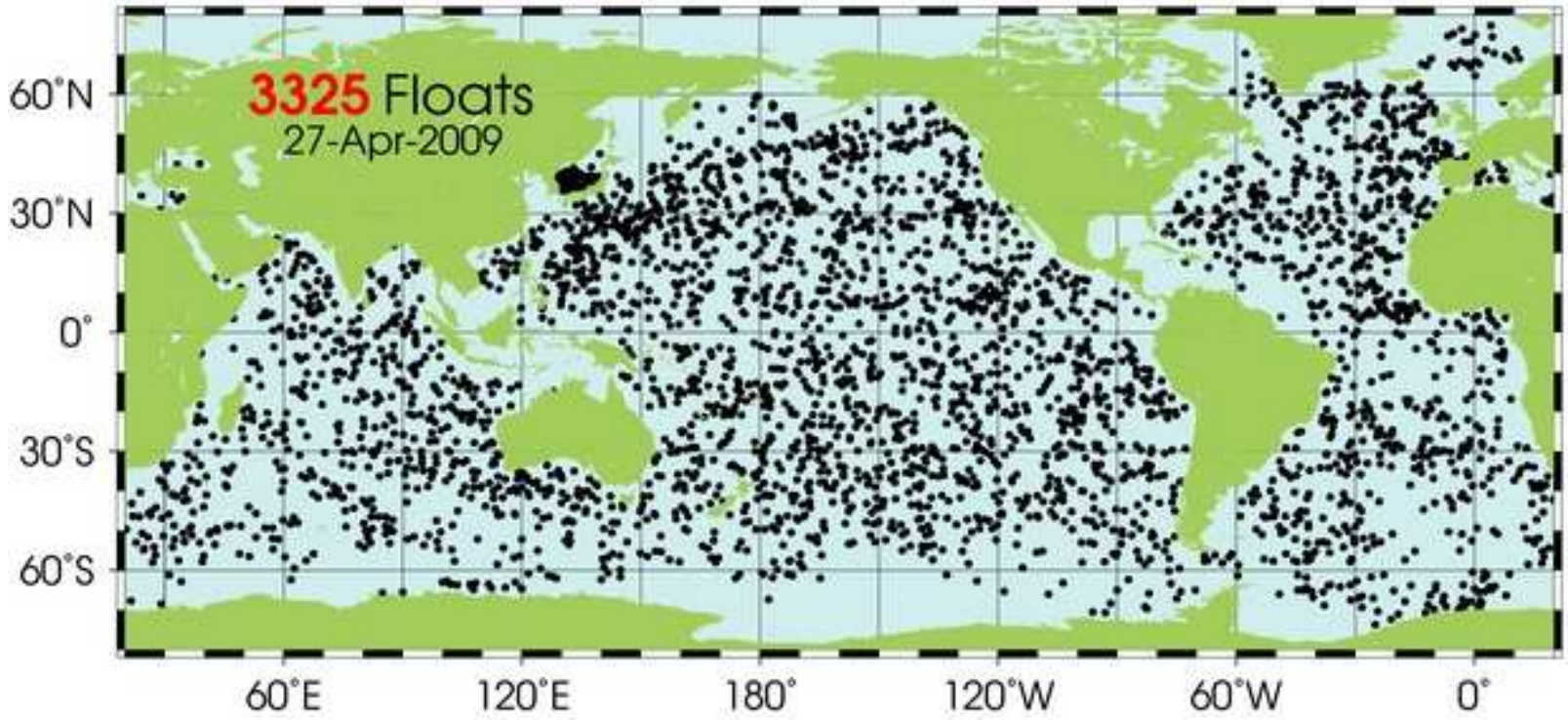
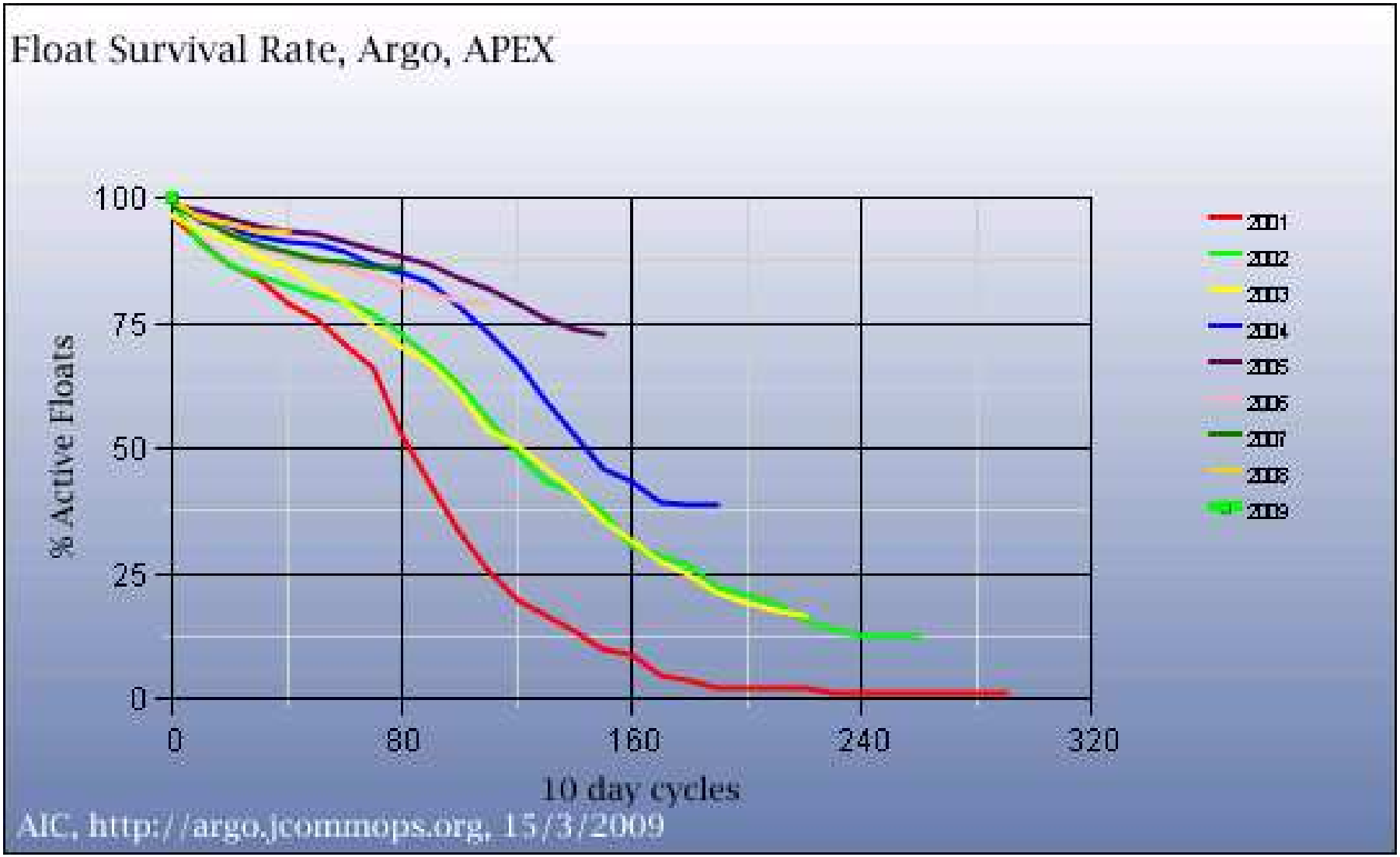
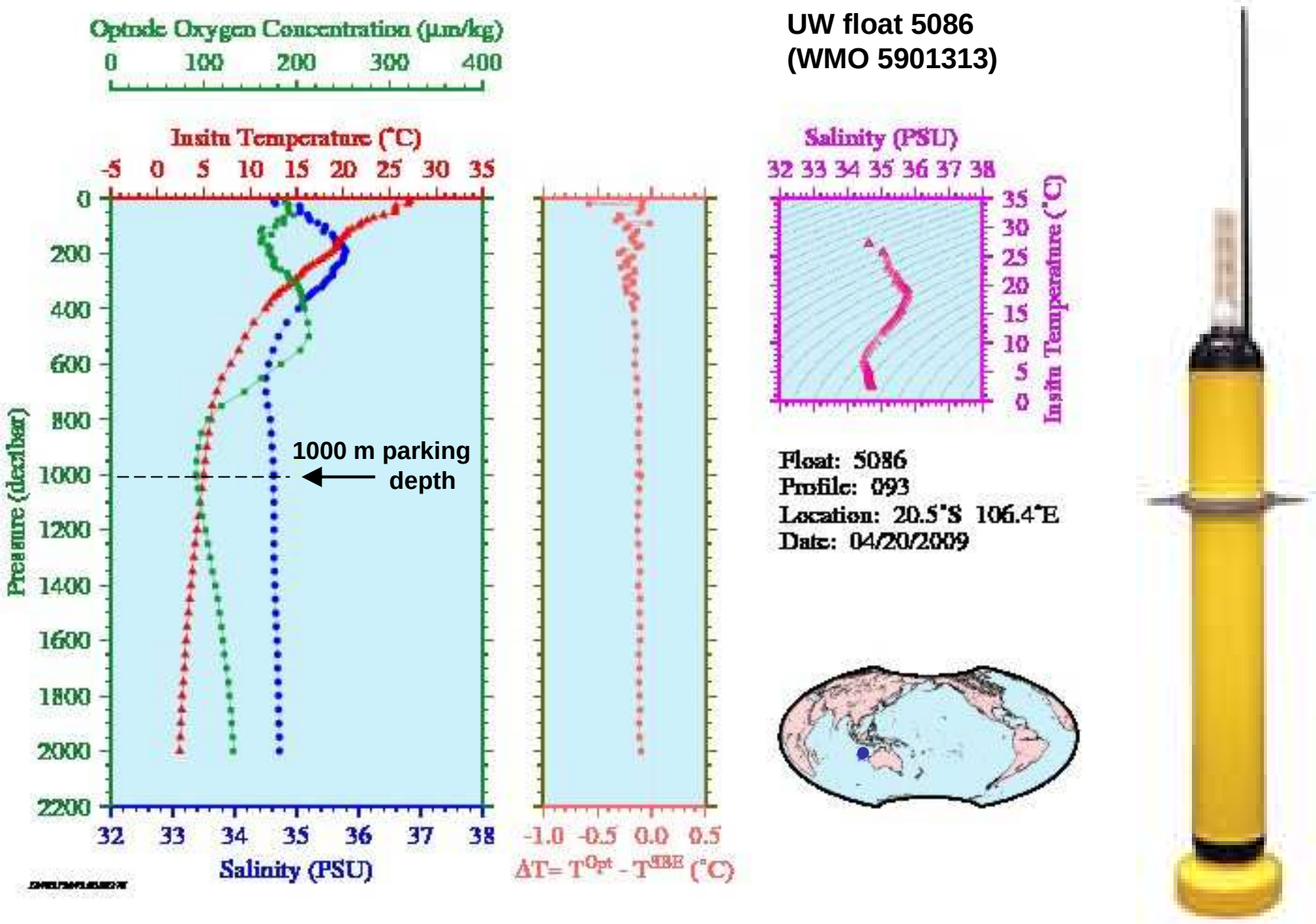


The Core Mission of Argo….

- **Global coverage of ice-free regions of the world ocean (± 60°) at approximately 300 km resolution (~ 3000 floats)**
- **No coverage in marginal seas**
- **Profiles at 10 day intervals**
- **Floats parked at 1000 m, data collected to 2000 m**
- **Floats operate for 4-5 years (> 150 profiles)**
- **Samples of temperature and salinity as functions of pressure collected on each profile**
- **All data made available in near real-time on the GTS and Argo Global Data Centers within 24 hours of collection**
- **Data periodically adjusted with delayed-mode *T*/*S*/*p* corrections**

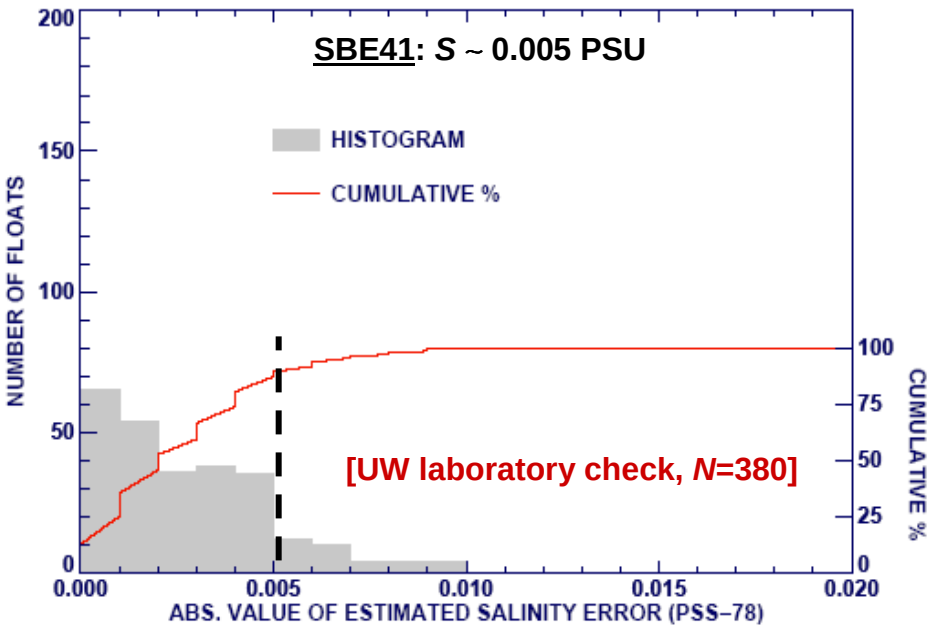


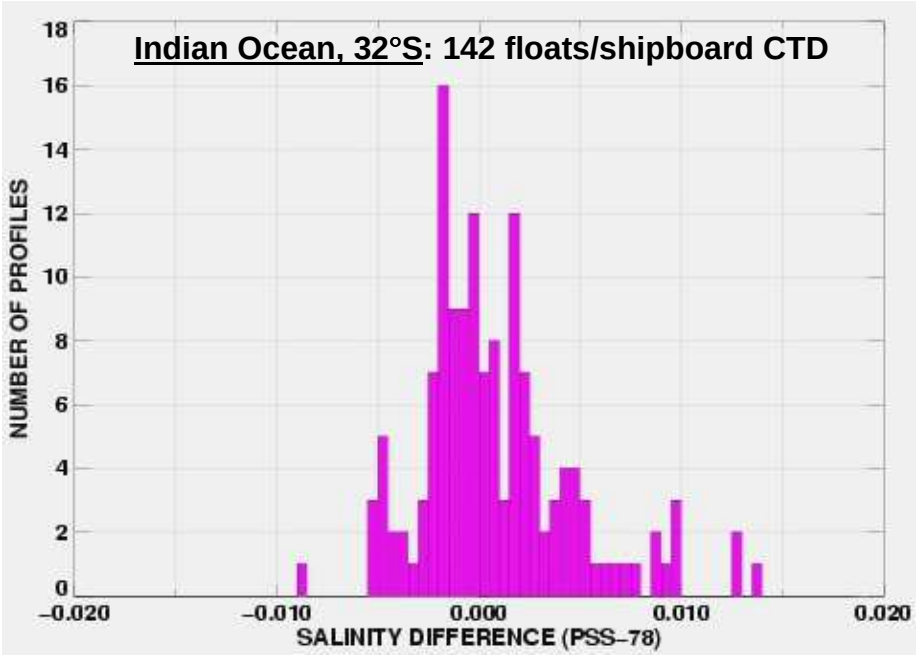
Steady progress in float reliability has been made since 2001; over 80% of floats deployed in 2009 could last 180 profiles or more



[Service ARGOS; 9 hours surface time; 71 levels]

SBE CTD performance in Argo: generally excellent



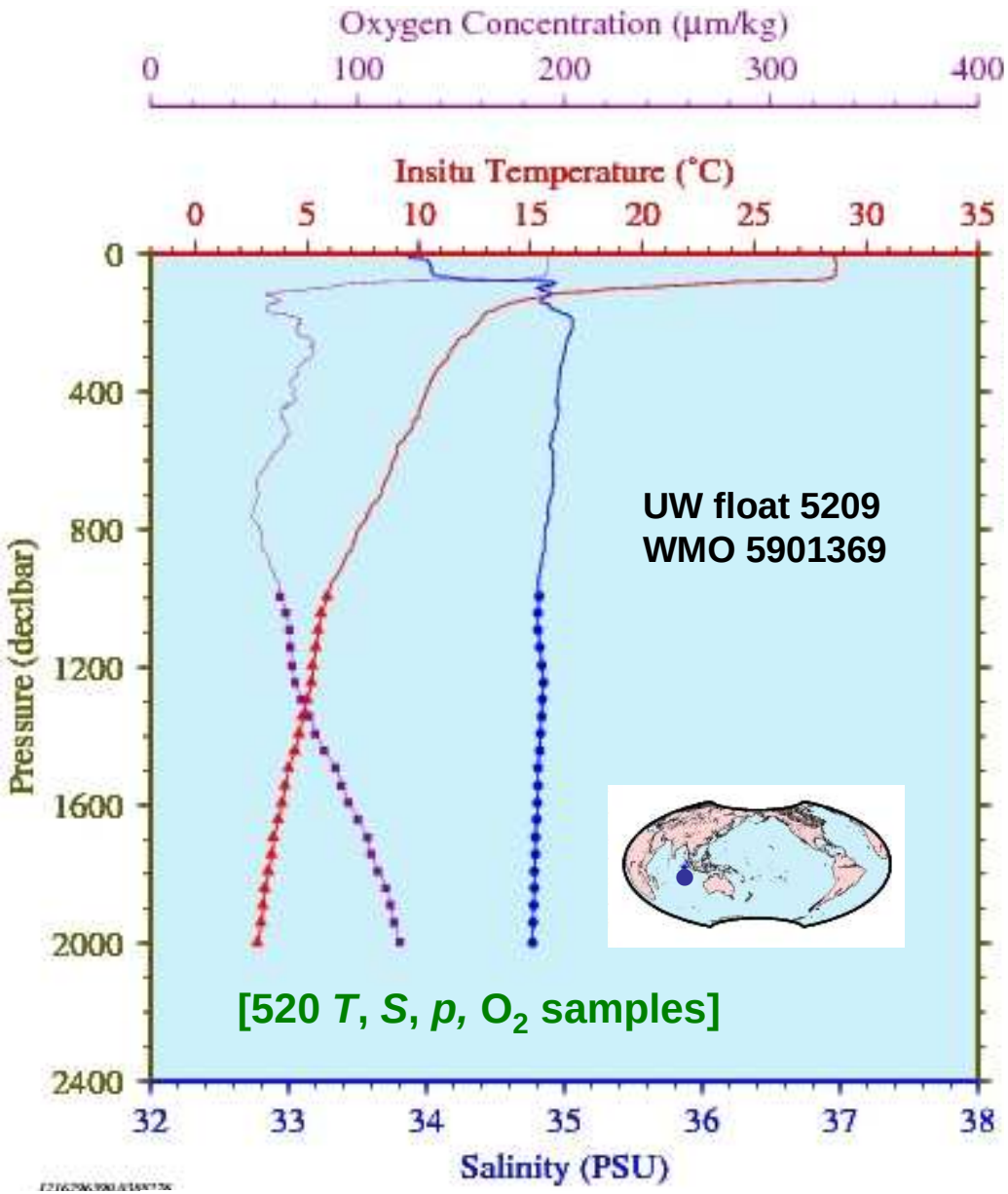


Results from recovered floats (Oka, 2005)

FLOAT	TIME (days)	ΔT (°C)	ΔS (PSS-78)	Δp (decibars)
29045*	840	0.00136	-0.0074	4.68
2900056*	730	0.00158	-0.0074	5.92
29051*	900	0.00100	-0.0125	0.72
41862†	1096	0.00030	-0.0060	0.06

* Deployed by Japan in the North Pacific † Deployed by the US in the North Atlantic

***DMQC results*: ~ 10 % adjusted to 0.01 PSU**



[GPS fix + 520 levels; 7 minutes surface time; 2-way communication, with > 30 possible commands]

Technological evolution in Argo: *Iridium*

Argo's policy concerning the addition of sensors to floats:

(1) *Risk to instruments*: Any design change has the potential to introduce new failure modes. New sensors should be deployed on a sufficient number of test floats and for a sufficient period of time to establish their potential for risk to the instrument and its operation.

(2) *Cost to the core mission*: Additional sensors have costs associated with their development, their incorporation into profiling float designs, procurement, communications and data management, and their impact on float energy budgets. For example, if a new sensor shortened float battery lifetime by 10%, then the core mission will require 10% more instruments plus associated costs of deployment and data management. In order to maintain Argo's core mission, all incremental costs borne by Argo must be offset by incremental funding.

Technological evolution in Argo: *additional sensors*

(i) Dissolved oxygen
(presently > 240 floats with O_2; see Gruber et al., 2007)

(ii) Nitrate

(iii) Cholorophyll, backscatter

(iv) Wind speed, rainfall

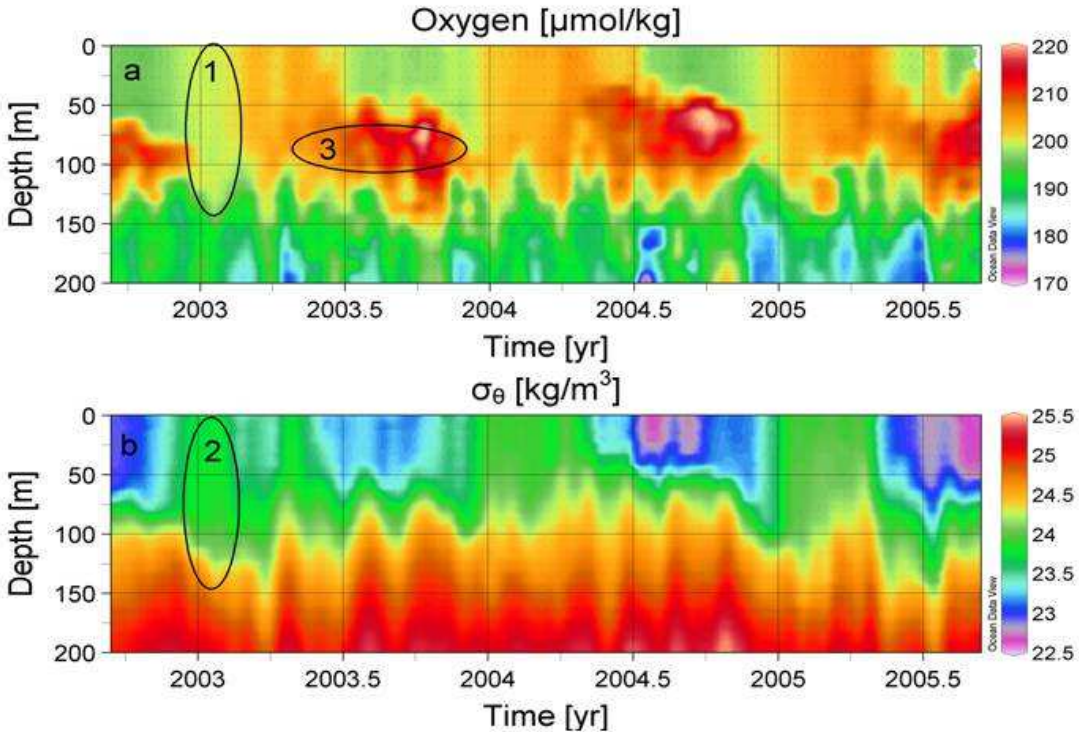
(v) Near-surface *T* and *S*

(vi) Ice detection

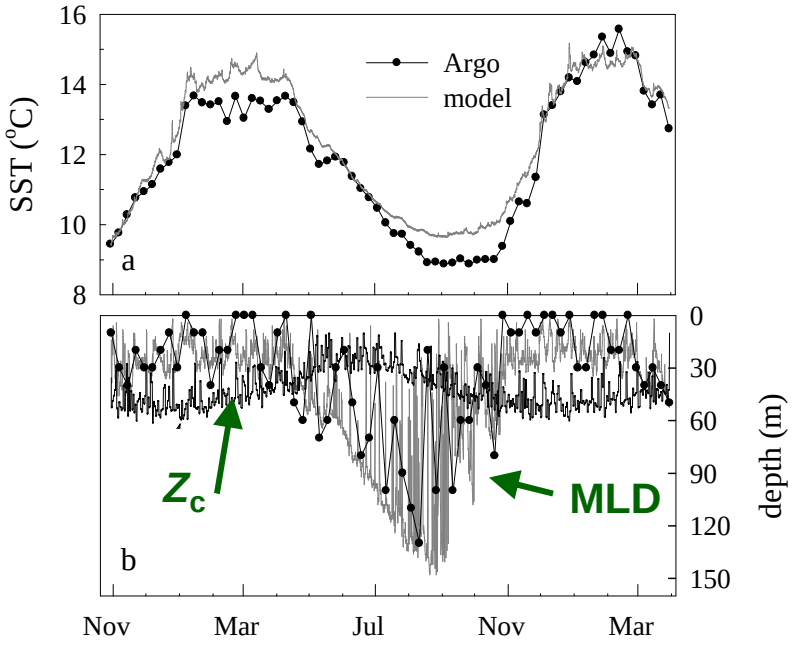
(vii) Others

Note: each of these float types has sufficient energy to operate for > 240 profiles. Some of these float types are available commercially, some are not.

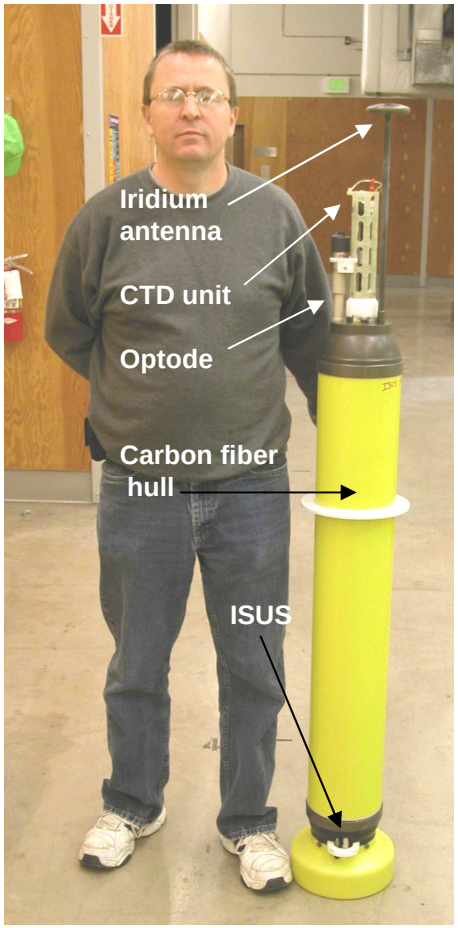
Subsurface production of O_2 in the subtropics, near HOT (Riser and Johnson, 2008)

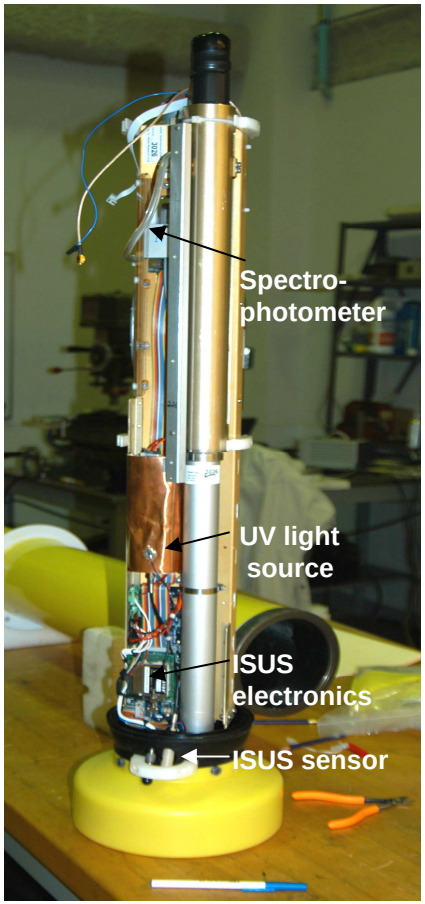


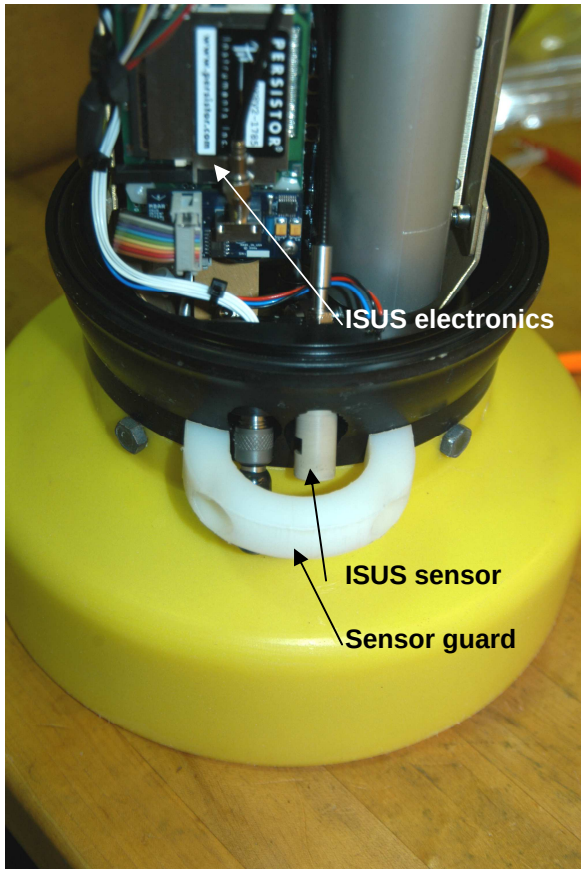
Measured and modeled SST, MLD, and compensation depth (Z_c) using O_2 data from floats at 45°S in the S. Pacific (Martz et al., 2008)



Nitrate Sensors on Profiling Floats:
A collaboration between UW and MBARI

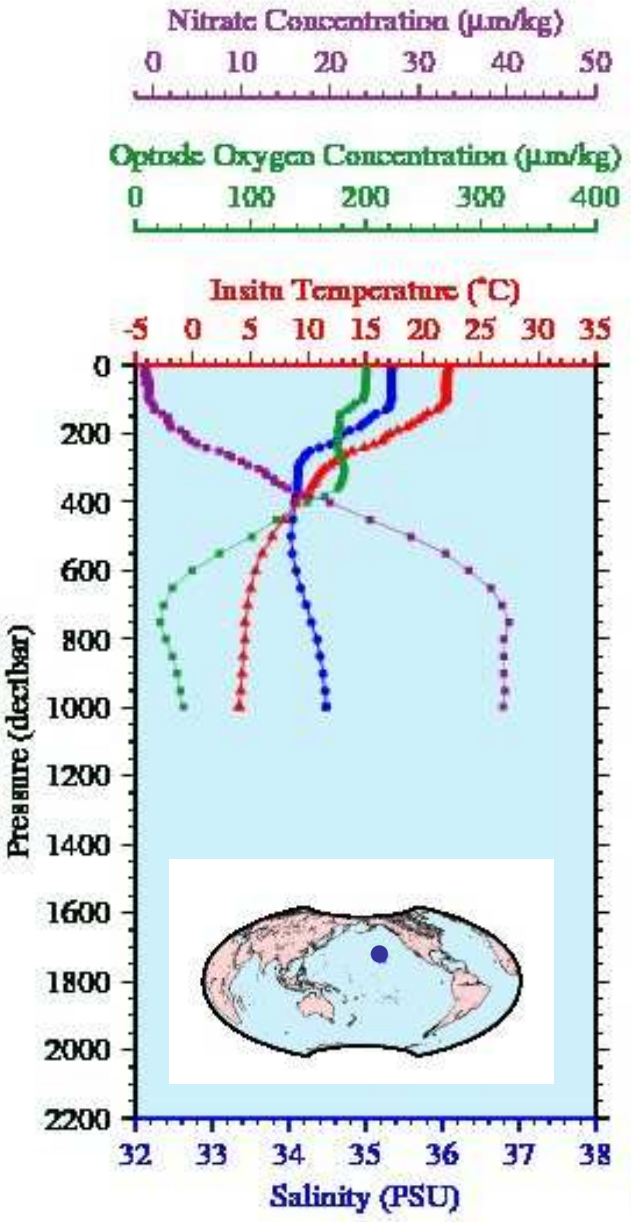


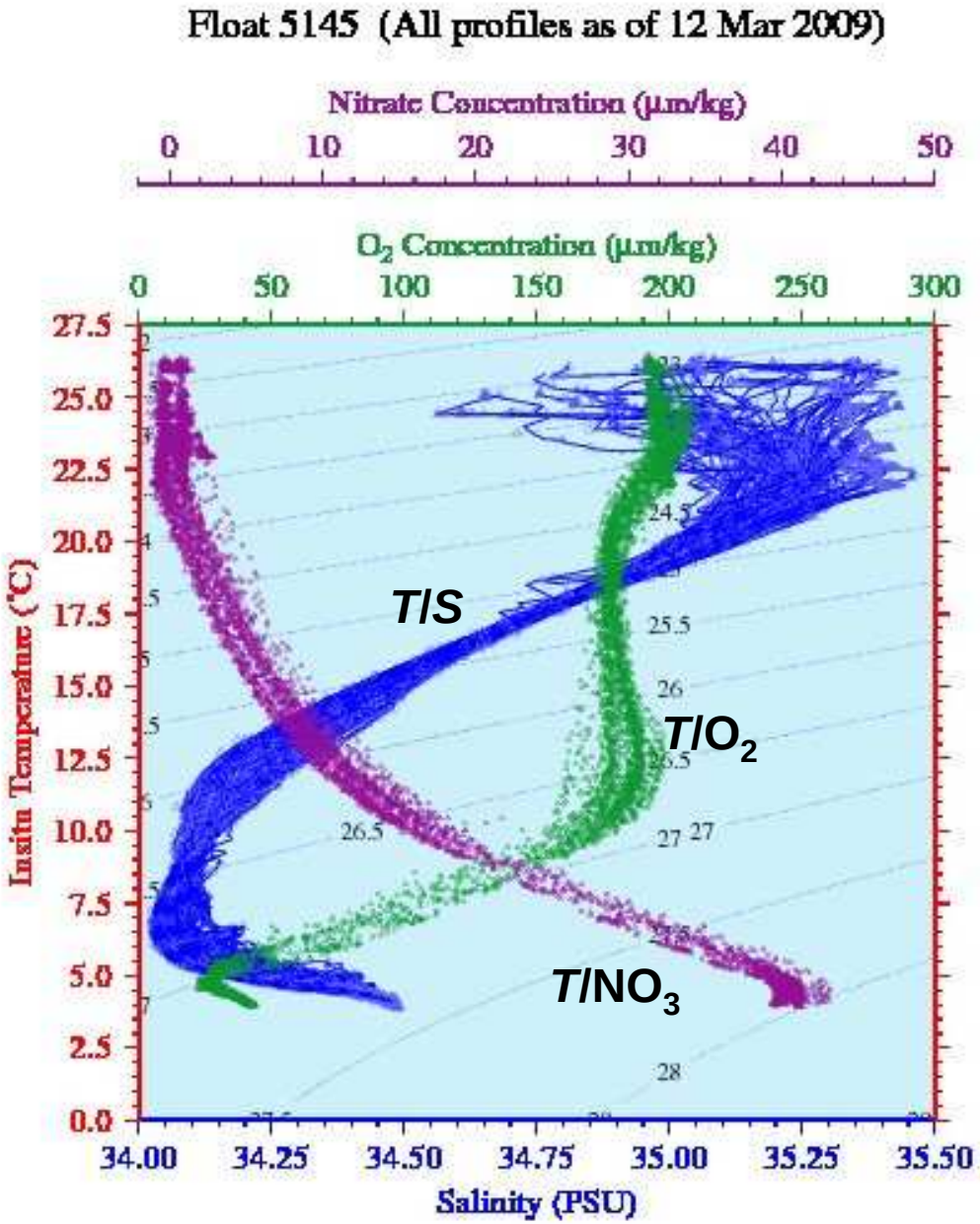




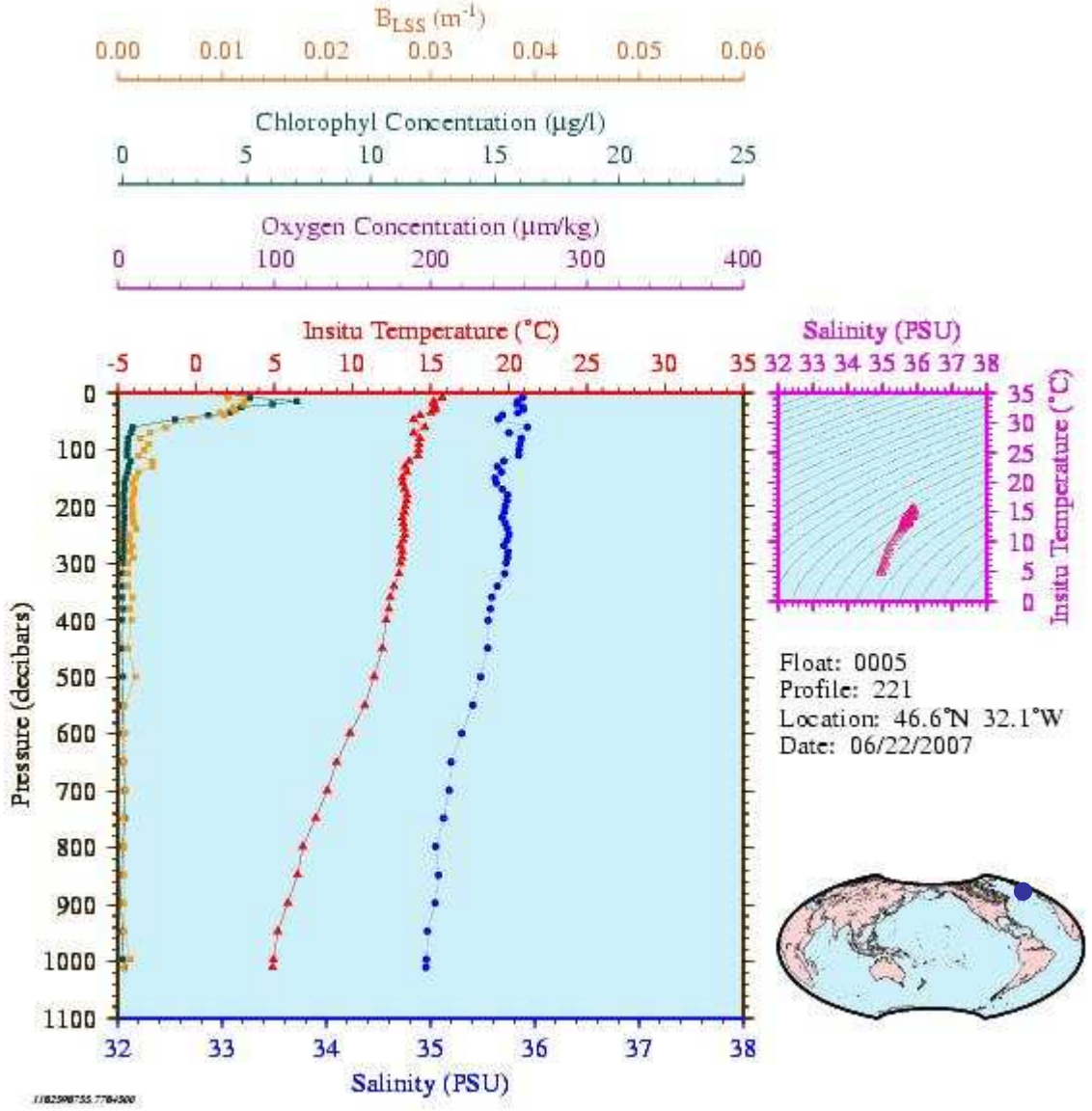
The NO_3 sensor (ISUS) consists of a spectrophotometer and a light source. With 3 Li battery packs, this float should be capable of about 275 profiles.

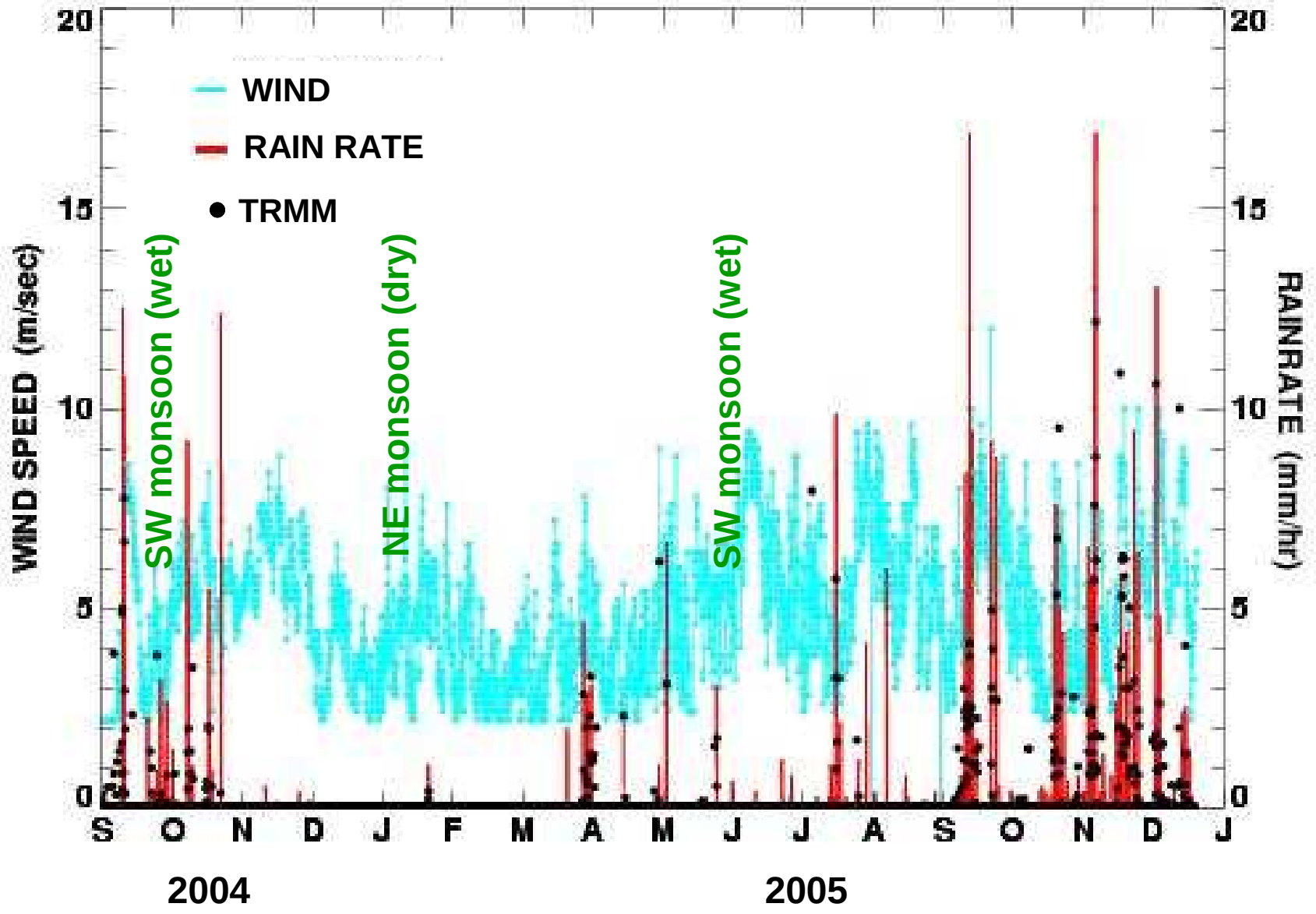
Nitrate: ISUS….



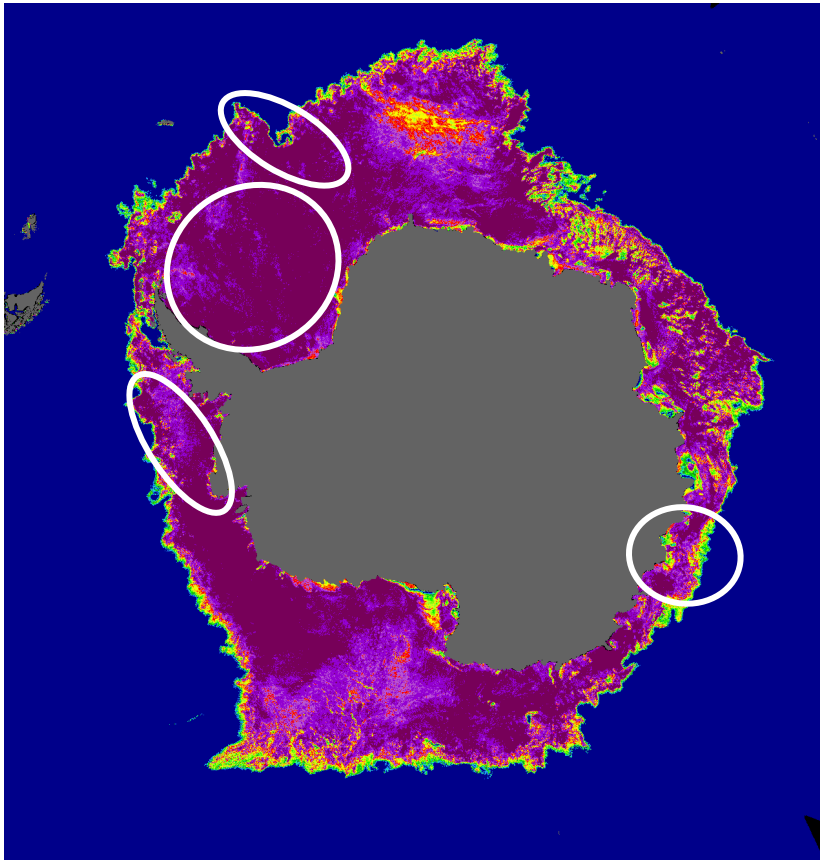


Chlorophyll and light scattering:

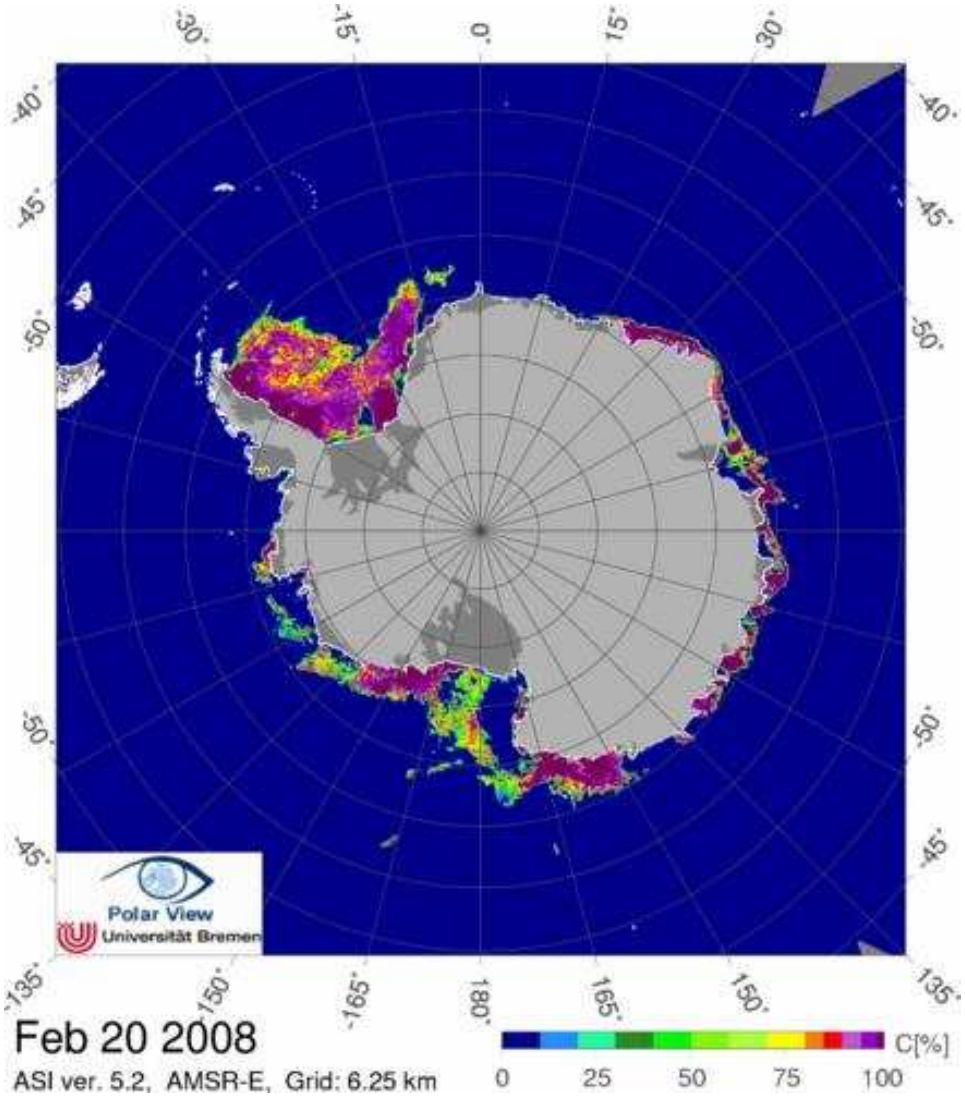




Wind speed and rain rate from the Bay of Bengal (UW float 0006)
[measured acoustically while drifting at the parking depth]

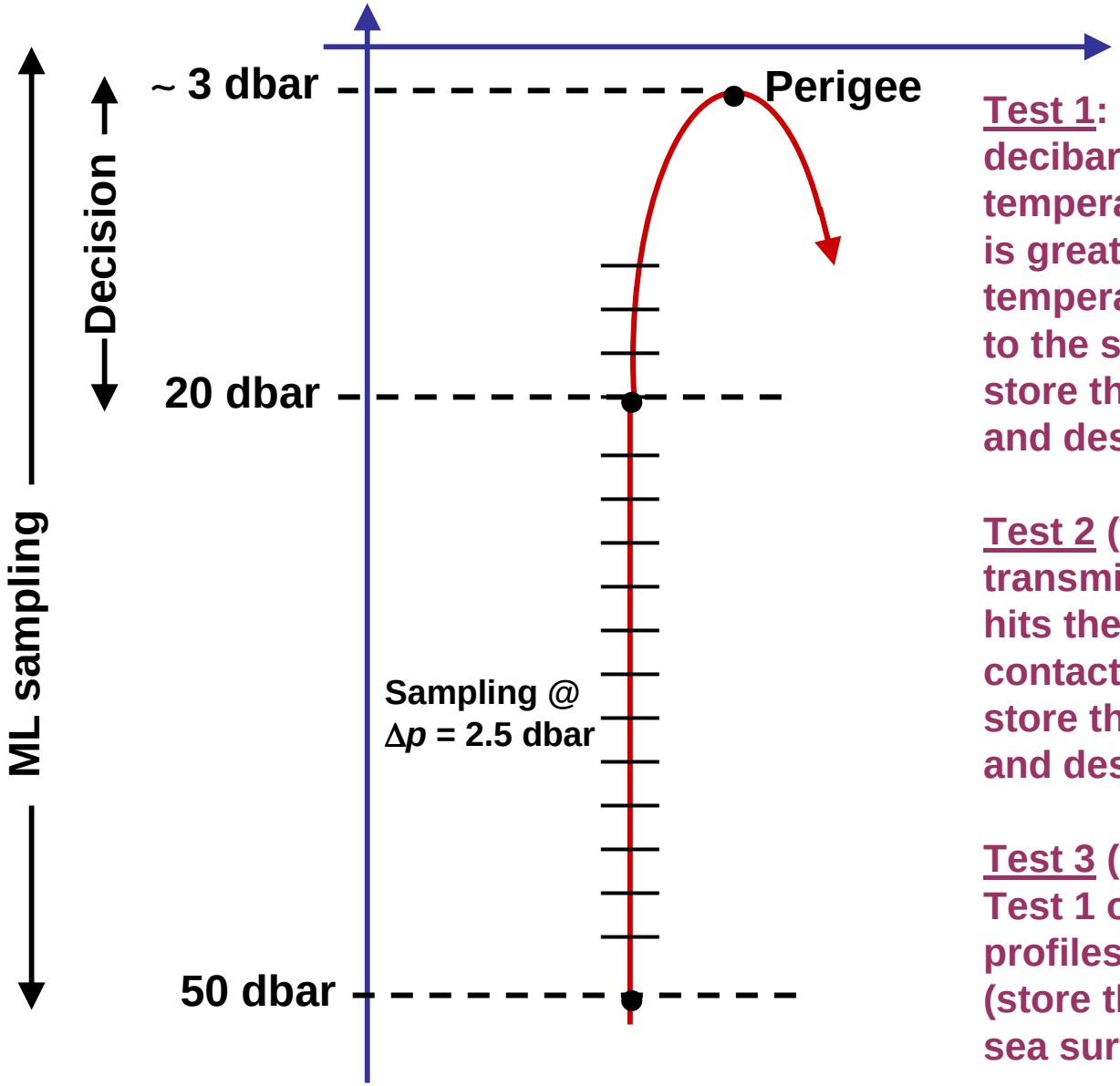


Aug 1 2007



Antarctic sea ice cover: recent seasonal extremes

Floats in the ice-zone (based on Klatt et al., 2007)….



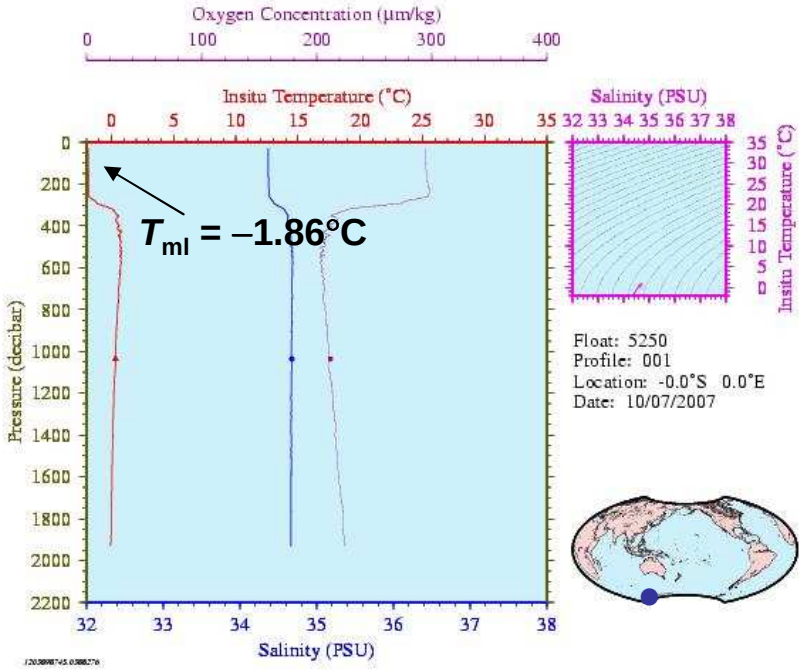
Schematic of the ice avoidance algorithm
(62 floats deployed; 90% working after 1-2 winters)

Test 1: Between 50 and 20 decibars compute the median temperature T_{ml}; if this temperature is greater than a threshold temperature T_{th} continue ascent to the sea surface. If $T_{ml} < T_{th}$, then store the profile, retract the piston and descend.

Test 2 (Test 1 fails): (a) No ice; transmit the profile. (b) The float hits the bottom of the ice; if no contact with a satellite in 2 hours, store the profile, retract the piston and descend.

Test 3 (ice breakup test): If either Test 1 or Test 2 fails on successive profiles, wait at least 2 more profiles (store them) before coming to the sea surface.

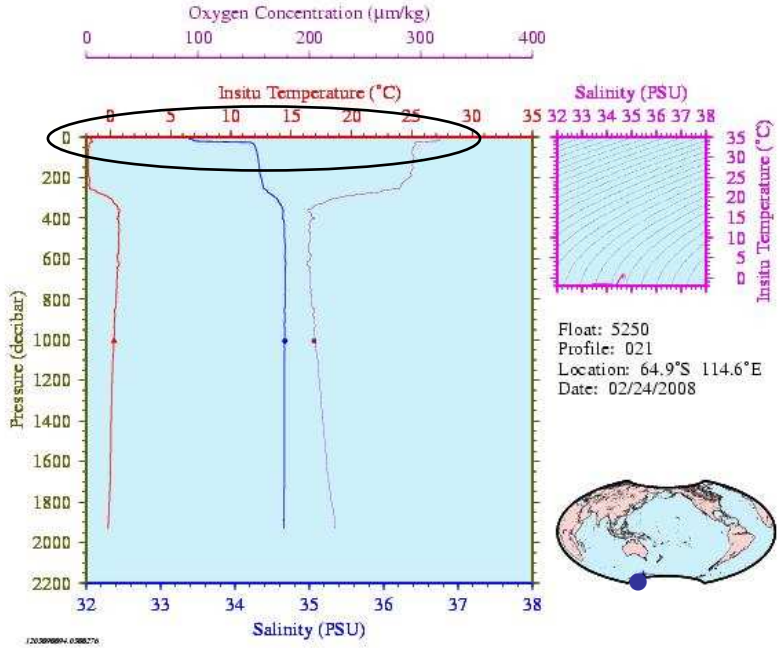
Test 4 (on or off test): In designated summer months, turn off Tests 1-3.



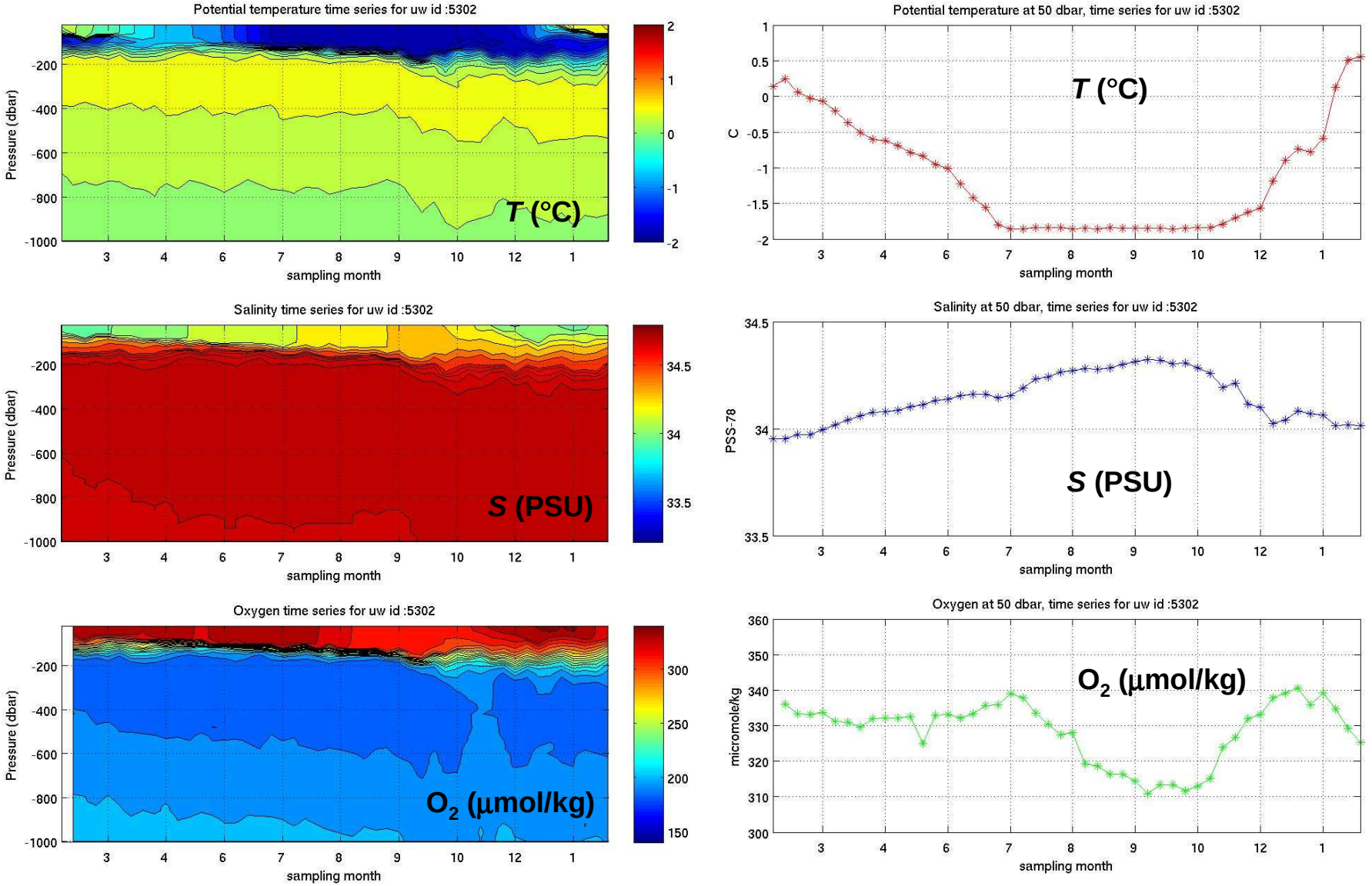
Water properties in Oct. 2007

Research questions: heat budget; fresh water budget; seasonal variability in the ice zone; oxygen uptake/production; nutrient (NO_3) variability; long-term changes?

Water properties in Feb. 2008



UW float 5250 (WMO 2900118)



Temperature, salinity, and dissolved O_2 from float 5302 (WMO 5901736), deployed in the Weddell Sea in January, 2008.

Summary

- Basic Argo floats can generally be expected to operate for 4-5 years
- The CTD data from Argo floats is of generally very high quality
- A number of additional sensors have been successfully added to Argo floats
- Additional sensors cannot distract from the core Argo mission
- The use of high-speed communications such as Iridium and Argos-3 opens the possibility for many new types of sensors and float capabilities
- Data collected on Argo floats must be made publicly available; provision must be made for data QC