

Performance evaluation of the optical dissolved oxygen sensor, ARO-FT, on Argo floats

Kanako Sato (k_sato@jamstec.go.jp), Hiroshi Uchida, and Shigeki Hosoda
JAMSTEC, Japan

(*) This work was supported by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan, Grant-in-Aid for Scientific Research on Innovative Areas (19H05700).

Introduction

- About 10 floats equipped with ARO-FT were deployed to the western North Pacific subtropical gyre in 2021.
- Aging by putting the sensor membranes under high pressure and calibration were performed for ARO-FTs before their deployment at our laboratory.

The aim of this study

Examination of ARO-FT performance on these floats.

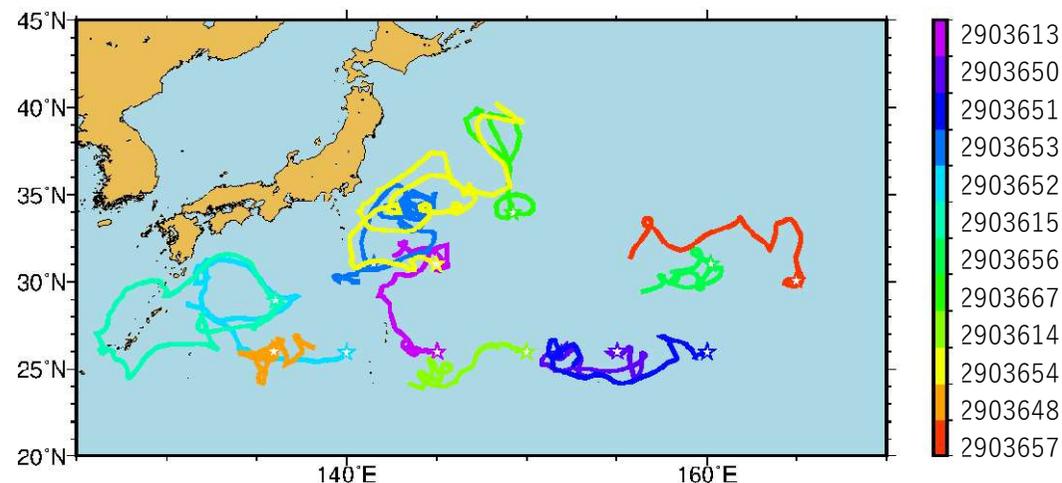


Fig 1. Trajectories of Argo floats with ARO-FT as to 22nd Sep., 2022. Star mean locations of each float's Prof. no.1

DOXY sensor types on Argo floats

Table 1. Comparison table of DOXY sensors on Argo floats, based on manufacturers' information

	Optode4330	Optode4831	ARO-FT	AROD-FT	SBE63
Manufacturer	Aanderaa xylem		JFE Advantech		Sea Bird Scientific
Range	concentration : 0~500 μ mol/L Air saturation : 0~150%		concentration : 0~425 μ mol/L Air saturation : 0~200%		Air saturation : 0~120%
Resolution	< 1 μ mol/L, 0.4%		0.01 μ mol/L		0.2 μ mol/kg
Initial accuracy	\pm 8 μ mol/L or \pm 5%		\pm 2.0 μ mol/L or \pm 2%		\pm 3.0 μ mol/kg or \pm 2%
Response time (63%)	< 25 sec		< 1 sec		< 6 sec
Depth rating	6000 dbar		2000 dbar	6800 dbar	6000 dbar
picture					

Comparison ARO-FT DOXY with bottle data at their deployment

*Before the following analysis, ARO-FT's DOXY were corrected by P and S based on recommendation by SCOR WG142.

Offsets
-10~-5 $\mu\text{mol/kg}$

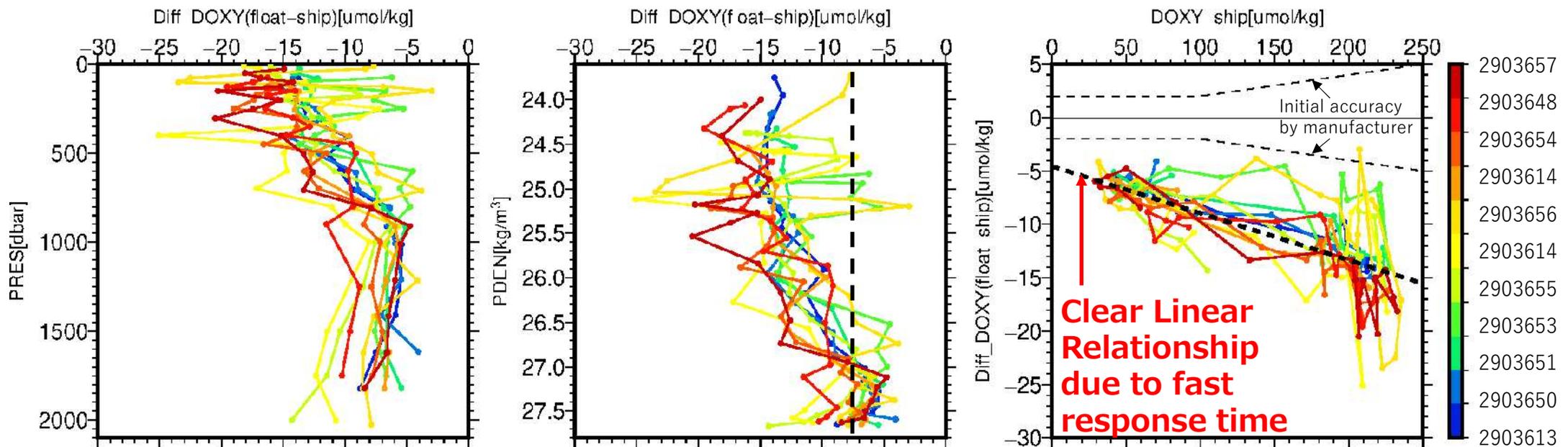


Fig 2. Profiles of difference between ARO-FT DOXY of float's Prof_no.1 and bottle data on isopycnal surfaces: (left) pressure and (middle) density. (right) Relation between bottle data and difference between DOXY of float's Prof_no.1 and bottle data on isopycnal surfaces.

NOTE: SBE63's DOXY mounted on floats in this layer does not have a clear linear relation with reference bottle data at the layer with large vertical gradient of DOXY.

Correction of ARO-FT DOXY by using bottle data at their deployment

Slope and offset for each float are calculated by using the linear relation described above.

Correction Equation $DOXY_{corr} = slope \cdot DOXY + offset$
slope: 1.02~1.065, offset: 3~8 μmol/kg

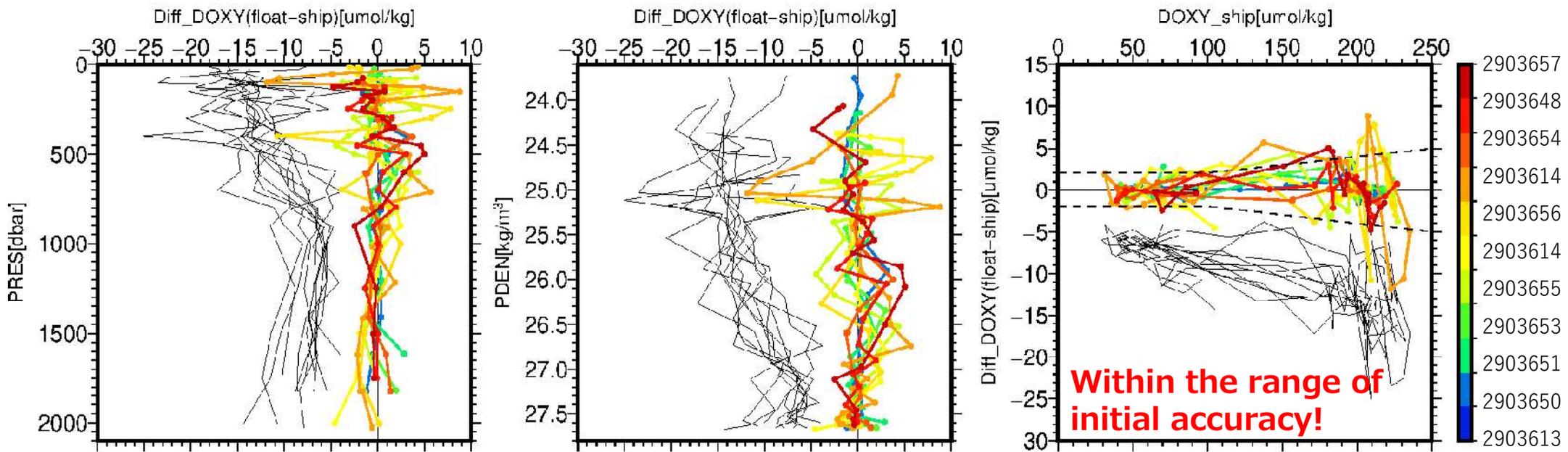


Fig 3. Same as Fig. 2, but comparison between ARO-FT $DOXY_{corr}$ of float's Prof_no.1 and bottle data. Black lines show ARO-FT DOXY of float's Prof_no.1 before correction.

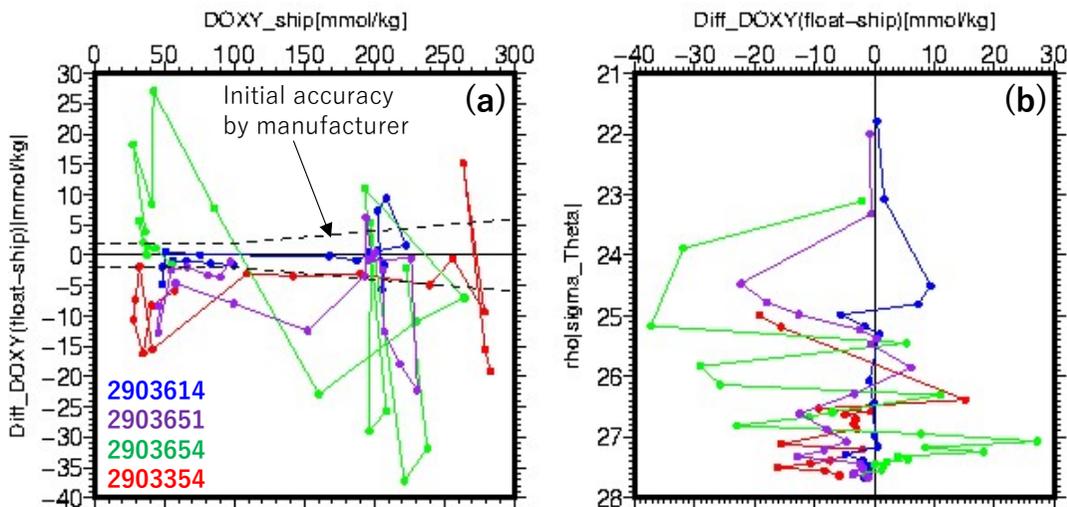
Difference between $DOXY_{corr}$ of float's Prof_no.1 and bottle data
Average: -0.5214 μmol/kg Standard deviation: 1.2297 μmol/kg

Time drift of ARO-FT

- Comparison between ARO-FT DOXY more than 100 days later after float's deployment and bottle data within 25 days and within 50 km from them.

Table 2. Result of searching bottle data within 20days and within 50km against the float profile above 100 days after its deployment.

WMO_NO	Cycle	Days after its deployment	Cruise	Station	Diff_Days	Distance [km]
2903614	65	208.1	RF2107	RF6912	0.07	5.02
2903651	61	220.3	RF2107	RF6926	22.15	19.63
2903654	126	520.2	KS-22-10	C011	3.57	0.689
2903354	243	776.5	RF2006	RF6729	16.91	42.95



- No evident time drift at low $DOXY \leq 50 \mu\text{mol/kg}$.
- The float operating for more than 2yrs show offset, but the difference between float and bottle data does not tend to increase with higher DOXY.

Fig 4. (a) Relation between bottle data and difference between $DOXY_{corr}$ of float's profile and bottle data shown in Table 2 on isopycnal surfaces. (b) vertical profile of difference between $DOXY_{corr}$ of float's profile and bottle data.

Examination time drift by using DOXY observed in air for every cycle

- The target floats for this analysis can measure DOXY in air when they reach at sea surface.
- Checking whether DOXY measured in air can be used to correct for time drift based on the method of Bittig et al. 2018.

⇒ Unfortunately, the floats were not likely to measure DOXY in air well...

Carry-over coefficients of them are larger than 0.5.

Comparison 2903614_065 DOXY_{corr} by two methods with its nearest bottle data

- Only using linear relation between float's DOXY of Prof_no.1 and bottle data at its deployment **good**
- In addition to the above correction, using 1/m slope of PPOX_prof_no65 calculated by DOXY in-air **bad...**

Future work...

- Monitoring and evaluating ARO-FT's time drift
- Development of correction method that suits ARO-FT

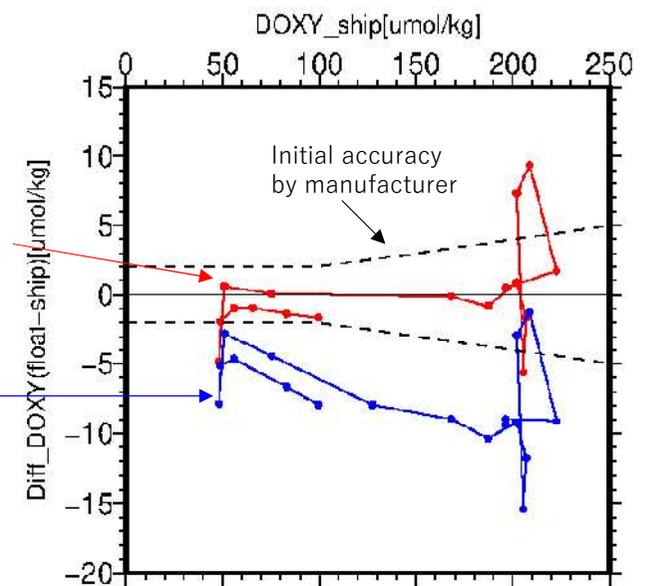


Fig 5. Relation between bottle data and difference between DOXY_{corr} of 2903614_065 profile and its nearest bottle data on isopycnal surfaces.