

Deep NINJA

A new model with RINKO-DO sensor

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JAMSTEC developed a new model of Deep NINJA with RINKO-DO sensor in cooperation with Tsurumi-Seiki (TSK) and JFE Advantech.

2 prototypes were assembled in July 2017, and they were deployed in the North Pacific (in July 2017 by R/V Mirai) and Southern Ocean (in January 2018 by R/V Investigator, CSIRO).

This presentation will show the evaluation of DO measurements by the float in the North Pacific.

Deep NINJA with RINKO-DO sensor

RINKO-DO sensor: AROD-FT (JFE Advantech Co., Ltd., Japan)

- Pressure rating: 68 MPa (= 6800 dbar)
- Initial accuracy: DO: $\pm 2\%$ R.D. or $\pm 2.0 \mu\text{-mol/L}$
Temp.: $\pm 0.01^\circ\text{C}$
- Resolution: DO: $0.01 \mu\text{-mol/L}$ Temp.: 0.001°C

AROD-FT sensor is available for public. Please contact with JFE.

Deep NINJA with RINKO-DO sensor

Specifications: [Points of major modifications](#)

- Maximum depth: 4,000 dbar
- Sensors:
 - SBE41CP (Sea-Bird Electronics, USA)
 - [AROD-FT \(JFE Advantech Co., Ltd.\)](#)
[Removable by users \(for sensor calibration\)](#)
- Data transmission: Iridium Short Burst (bi-direction)
- Positioning: GPS
- Lithium Batteries
- [Measurements](#)
 - Able to arrive at sea surface around a preset local time.
(e.g., the DO observations around 0 hour in midnight)
 - 10 (x2) DO measurements at sea surface
(following the recommendation of SCOR WG142)



Evaluation of float data

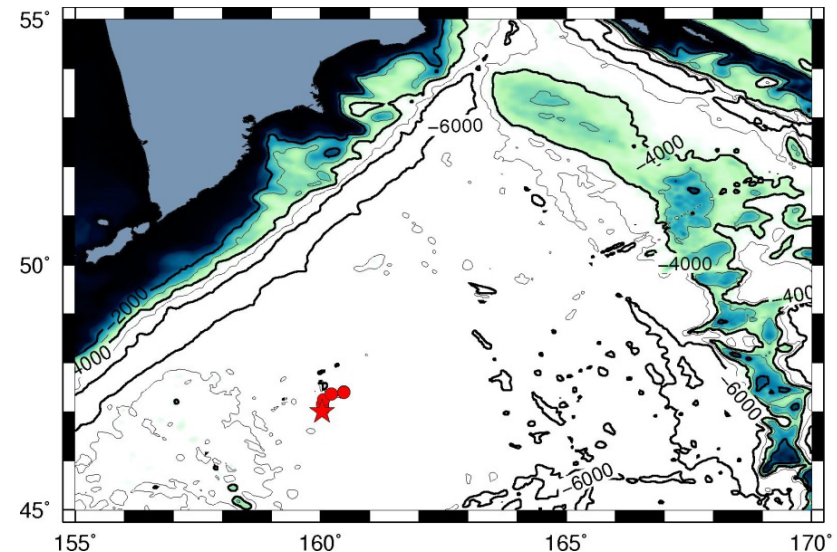
Deployments

- 1st (SN23) at MR17-04 (North Pacific)
Date/Time: 2017/7/23 23:11
Position: 47.0N 160.0E (St. K2)
- 2nd (SN24) at CSIRO cruise (Southern Ocean)
Date/Time: 2018/1/29 16:42
Position: 63.36S, 139.85E

It (and another 2 floats) works very well. Thank for all AU persons cooperated for deployment.

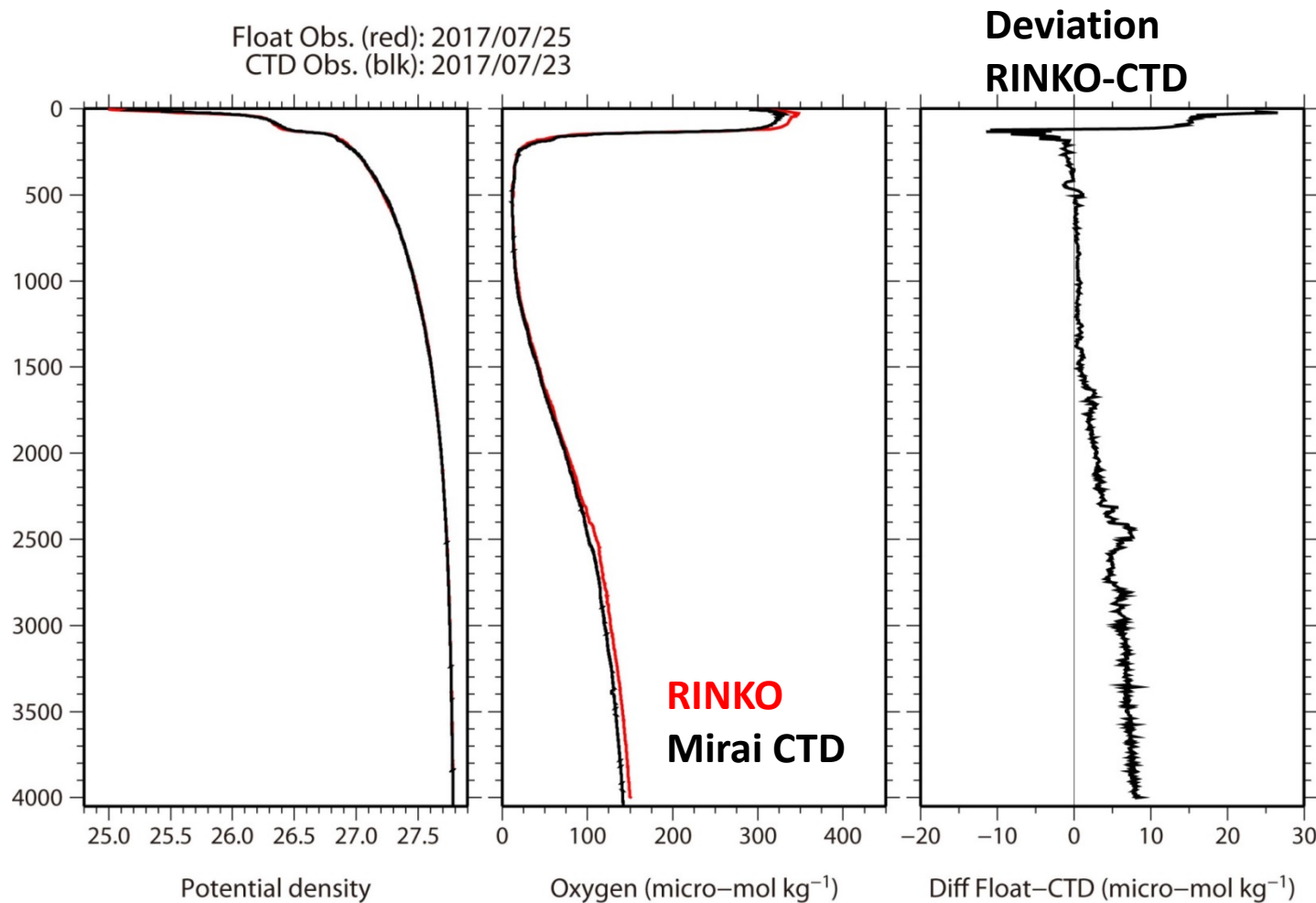
Comparison

- Reference (for 1st Deep NINJA: SN23)
Mirai CTD at St. K2 (provisional; not final)
Date/Time: 2017/7/23 19:01
- 1-st profile of SN23 was conducted nearby St. K2: Difference of 31.5 hours and 8 km
- SN23 stayed around St. K2 for its lifetime (9 cycles): within 75 km from St. K2.
=> Available for evaluation of temporal change of sensor accuracy.



Evaluation of RINKO-DO measurements

RINKO DO data were compared with Mirai CTD after the official adjustments for Pressure and Salinity.



Comparing DO on isopycnals to remove the effects of short-term heaving.

Evaluation of RINKO-DO measurements

RINKO-DO deviation was expressed as a linear function **through the origin**.

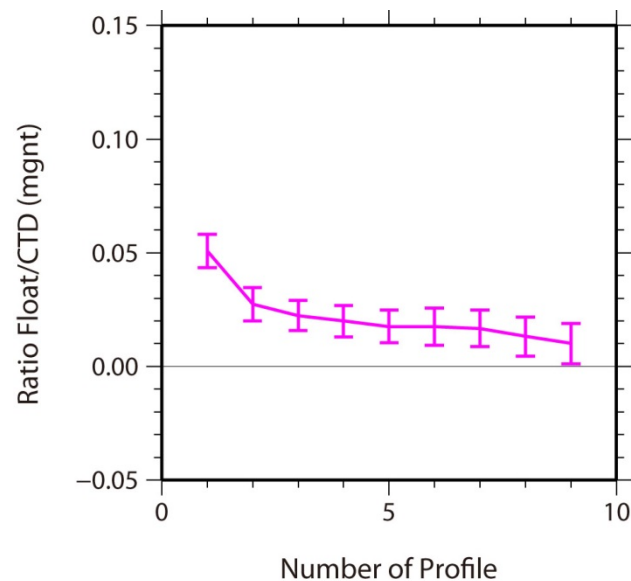
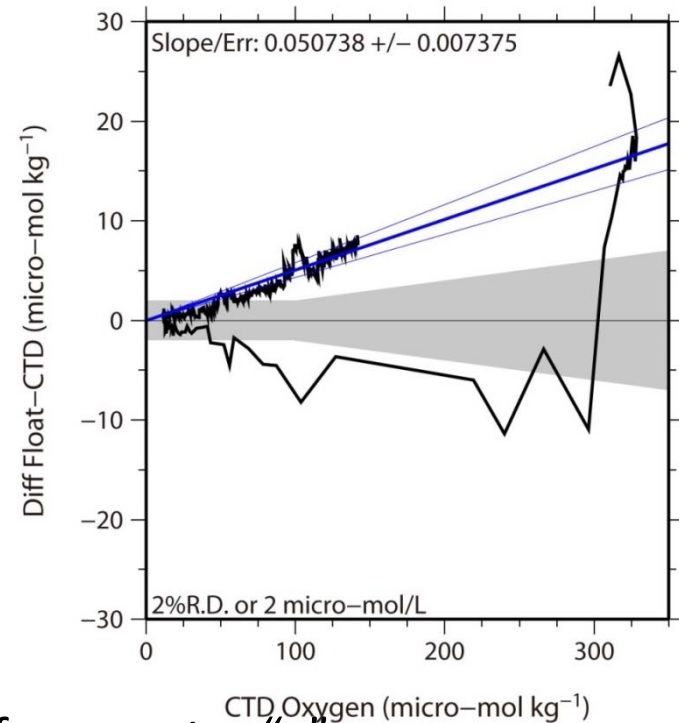
$$\text{DO}_{\text{float}} - \text{DO}_{\text{ref}} \sim a \times \text{DO}_{\text{ref}}$$

$$\text{DO}_{\text{adjusted}} (= \text{DO}_{\text{ref}}) = \text{DO}_{\text{float}} / (1+a)$$

⇒ “a” was obtained with Least Square Method for the data $>27\sigma_\theta$ (below about 350m).

$a = +0.051 \pm 0.008$ (Blue line)

“One” point of reference is required for adjustment.

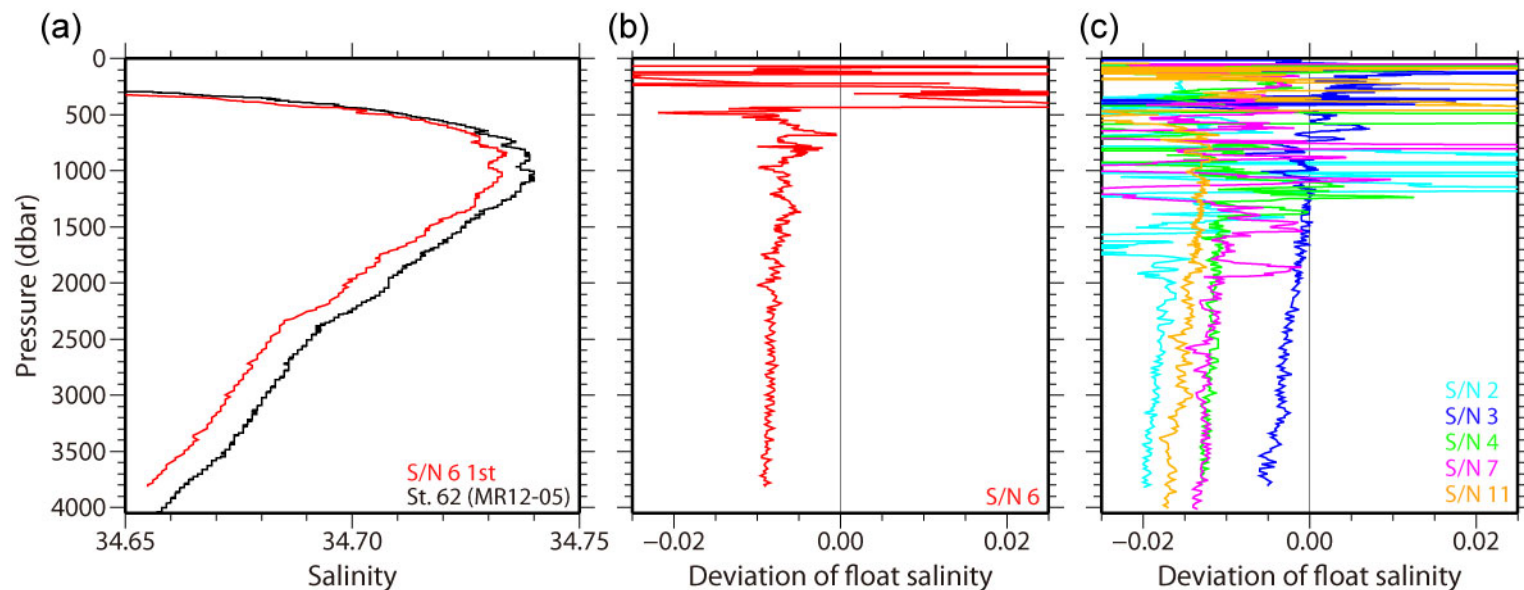


Temporal change of parameter “a”

- Evaluated for the measurements deeper than $>27\sigma_\theta$ (below about 350m).
- Gradually decreased by measurement. Stable around +0.01 (at 9th obs.) ??

Unfortunately, the float SN23 died at 9th cycle from a hardware failure... We hope the SN24 in SO will operate for a longer period...

Note: Salinity bias of Deep NINJA measurements



- Salinity of Deep NINJA has the bias towards fresh with component pressure dependency for ALL CASES of the reference available.

$$\Delta S = S_{\text{offset}} + a \times P$$

- The average of a (14 cases) was evaluated at about $-1.6 \times 10^{-6} \text{ [dbar}^{-1}]$
 \Rightarrow corresponds to about 13.5×10^{-8} of P_{corr}
- 6 Deep NINJAs are waiting for the reference CTDs...

