Preliminary Results on the Field Tests of "New Profiling Float of Japan (NINJA)"

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1. NINJA (New profiling float of Japan) float and its field experiments

The Tsurumi Seiki Co. (TSK), who is a supplier of XBT (expendable Bathy Thermograph) and XCTD (expendable Conductivity Temperature Depth profiling system) to the world market, has developed the new profiling float mainly to contribute to the international Argo program. In June and September 2002, the seven proto-type profiling floats manufactured by TSK, named "New profiling float of Japan (NINJA)", have been launched in the north Pacific. Although two floats were not transmitting, five floats worked and transmitted data. Among five floats, two floats carrying the SBE41 sensors of electrode conductivity showed excellent temperature and salinity data. The results of salinity comparisons of two sensors with the *in-situ* CTD data are reported later in details.

2. Specifications of NINJA

The nominal specifications and the schematic picture are shown in Table 1 and Figure 1, respectively. The most remarkable feature is its buoyancy control system. The plunger pushed out directly from the pressure cage controls the buoyancy of the float; therefore the float will be more accurate to control its buoyancy due to less effect of pressure and temperature to the plunger. Users can select the sensor type from the SBE41 CTD sensor (NINJA-S) or the TSK-original CTD sensor (NINJA-T). The float is designed to make measurements of more than 150 temperature and salinity profiles in 5 years by lithium battery packs. The transmitted data via Argos system showed quite few packets loss. The software in controller has still few functions to make measurements and only has the park and profile feature on demands from users with the maximum profiling and parking depth of 2000 meters.

3. Results from the field tests

Table 2 shows the list of field tests for the five NINJA floats in the North Pacific. The float with Argos-id 20231 was launched from R/V Mirai in June 2002, and the other four floats were from R/V Kaiyo in October 2002. In these two cruise, we launched two more floats, however, they were not transmitting any data probably due to the failures of adjustments of weight and lost of contact from connector. These problems have been fixed later.

After launching these floats, the CTD (SBE9plus) measurements were performed at the same site for comparison. Figure 2 shows the T-S comparison (left panel) and the salinity differences (right panel) of the float data of Argos-id 20486 carrying SBE41 CTD from the *in-situ* CTD (SBE9plus). The *in-situ* CTD was performed just after launching float from R/V Kaiyo, so the CTD measurement was 10 days earlier than the first profile of the float to be compared. During 10 days, the float was also drifted several miles in case, thus, strictly speaking the comparison was not performed at the same time and the same site. Because of the above mentioned reasons, Figure 2 indicate the less consistency between the *in-situ* CTD and the float data above 3 degree C (above 1500 meters). However, the stable structure in a deep ocean makes the *in-situ* salinity comparison possible if distance and period are not long. Focusing on the deep layer below 1500 meters, which is equivalent to the temperature range below 3 degree C in this case, the salinity differences (right panel) of the first profiles by the float (red star) from the *in-situ* CTD show small negative offset. After the second profile marked by yellow, the T-S relations from the float shows close to that by the *in-situ* CTD data, and also the salinity differences of the float from the *in-situ* CTD salinity are within 0.01psu in the lower temperature range below 3 degree-C. After 9 dives, the float data shows the almost same T-S relations, therefore we guess that the salinity (conductivity) sensor do not show time-drift.

As the TSK-original conductivity sensor for the float has started to develop in 2000 and is still in developing stage, the salinity data from the NINJA-T carrying the TSK original sensor show higher salinity (0.02-0.03psu) in comparison with the *in-situ* SBE9plus CTD data (figures are not shown here). As the TSK temperature sensor is assumed to be stable, we guess that the TSK conductivity sensor may need further improvements to achieve higher quality data. For more information, contact to sales@tsk-jp.com for hardware and sales information, and contact to andouk@jamstec.go.jp for our NINJA data and our experiments in this report.

Tables and figures

Table 1 the specifications of the NINJA float.

Model name	NINJA-T (TSK-original inductive CTD sensor) NINJA-S (SBE CTD sensor, model SBE41)
Dimensions	16.5 cm diameter x 215 cm long
Buoyancy Engine	Plunger type with the 350 cc displacement
Mass	32 kg in air
Autonomy nominal	5 years and 150 profiles
Operating depth	2000 meters at maximum

Table 2 List of NINJA floats used for the field tests. The float of Argos-id 11087 and 20480 were originally set these mission cycle to be 3 days, however, they became to the “emergency mode” due to the failure of adjustment of weight. The numbers of profile as of January 9, 2003 are shown.

ARGOS ID	CTD	Mission cycle	Deployed info.		No. of Profile	Remarks
			Date	Location		
20231	TSK	3 days	Jun., 29, 2002	35.142N, 142-591E	55	No transmitting after Nov.28, 2002
10864	TSK	3 days	Oct., 4, 2002	28.986N, 148-018E	33	On schedule
11087	TSK	1 days	Oct., 4, 2002	28.986N, 148-020E	38	Deep-dive emergency, no transmitting after Nov. 5, 2002
20480	SBE	1 days	Oct., 4 2002	28.987N, 148.015E	90	Shallow-dive emergency, and stop transmitting due to battery shutoff (expected) after Dec, 2002
20486	SBE	10 days	Oct., 5, 2002	26.768N, 148.918E	9	On schedule

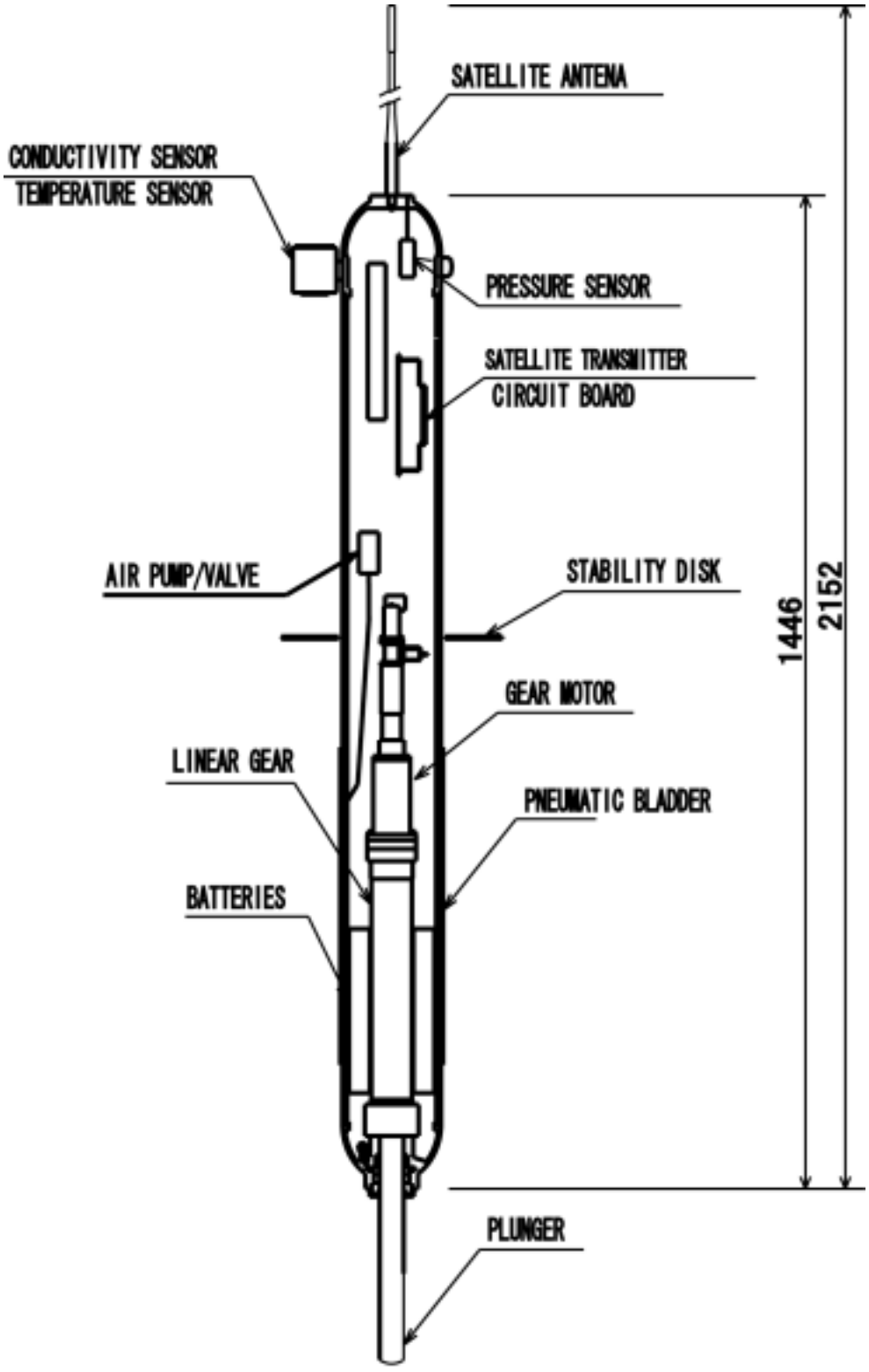

Figure 1 Schematic diagram of NINJA-T, carrying the TSK original CTD sensor on its top.

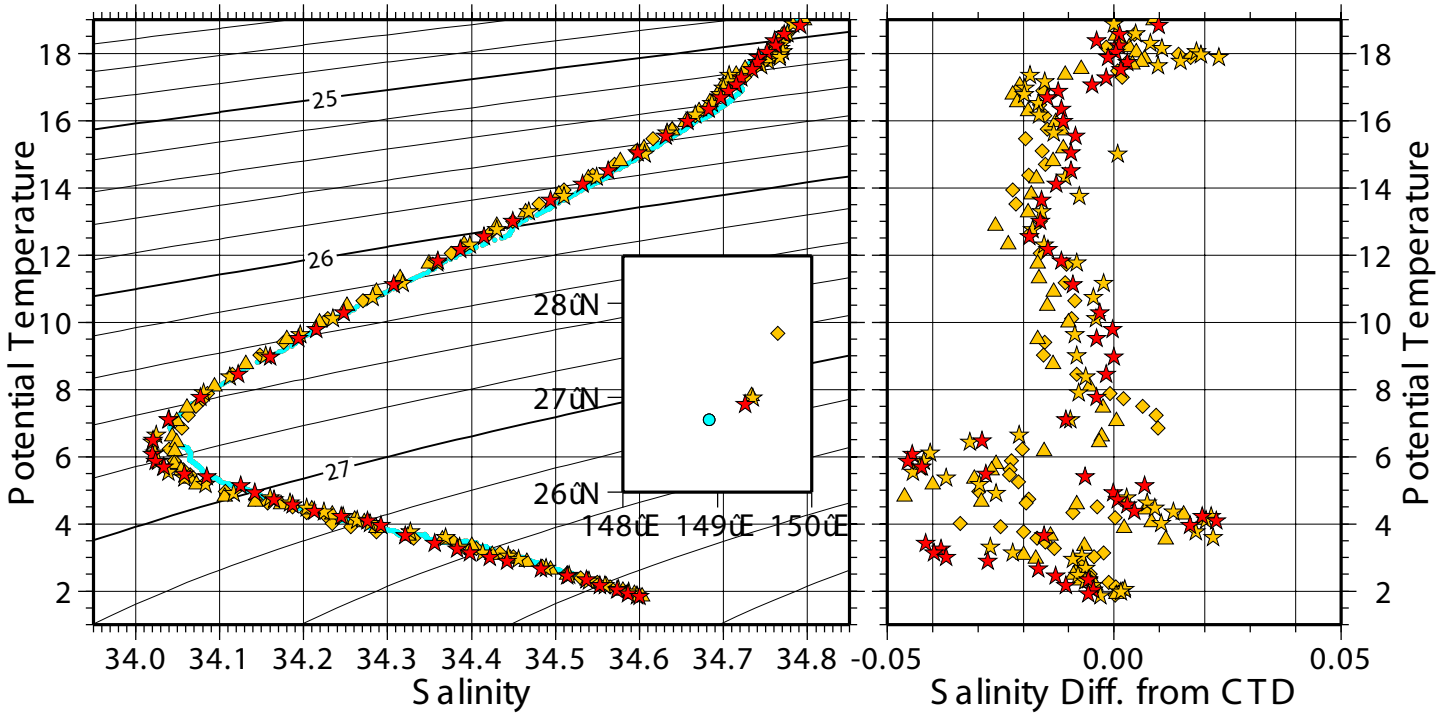

Figure 2 The T-S comparison (left) and salinity difference from the in-situ CTD data in temperature range (right) of the NINJA float (Argos-id: 20486) carrying the SBE41 CTD. Blue dots in the left panel indicate the in-situ CTD data, and red stars indicate the first profile data of the float. Yellow stars, triangles and diamonds indicate the second, third and fourth profile of the float, respectively.