Venice, Italy
Sep. 27-29, 2012

Deep NINJA: A new profiling float for deep ocean observation

Taiyo KOBAYASHI[1] (E-mail: taiyok@jamstec.go.jp)
K. AMAIKE[1,2], K. WATANABE[1,2], T. INO[1,2],
K. ASAKAWA[1], T. SUGA[1], T. KAWANO[1], and T. HYAKUDOME[1]
1: JAMSTEC, Yokosuka, Japan 2: Tsurumi Seiki Co. Ltd., Yokohama, Japan

Summary:

We will introduce a new profiling float for deep ocean observation, Deep NINJA, which has been developed by Tsurumi Seiki Co. Ltd. (TSK) and JAMSTEC. It is designed to observe the deep ocean up to 4000 dbar depth everywhere in the global ocean. Its size is about 210 cm in height (with antenna) and about 50 kg in air weight for easier operation. Iridium SBD system on board enables the two-way communication with operators on land and float locations at the sea surface are fixed by GPS. Lithium batteries are loaded to extend the duration of operation in the sea.

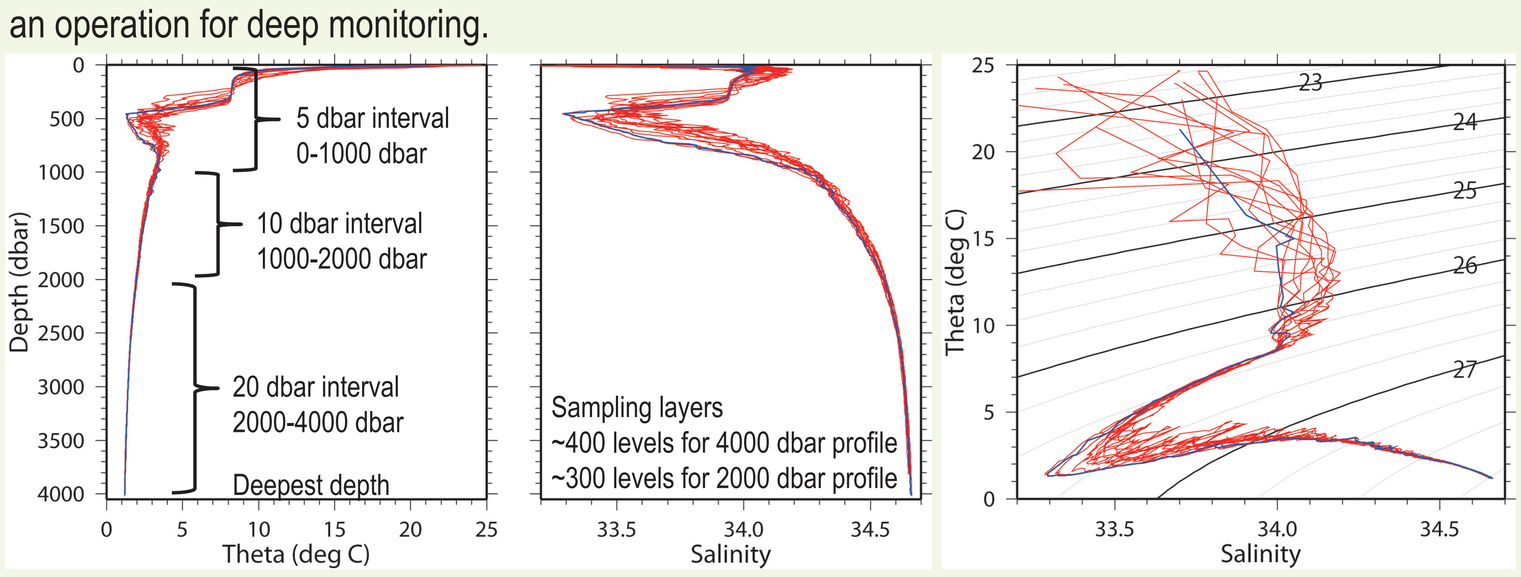
Recently, we carried out a deep field test east of Japan in 2012 summer, in which 2 Deep NINJA succeeded to measure profiles from 4000 dbar depth. Until now (as of Sep. 24, 2012), one of them has observed 12 deep profiles. In 2012-13 winter, 4 Deep NINJAs will be deployed in the Indian sector of the Southern Ocean from R/V Mirai and they will monitor deep/bottom waters newly formed and their modifications for years.

Specification of Deep NINJA

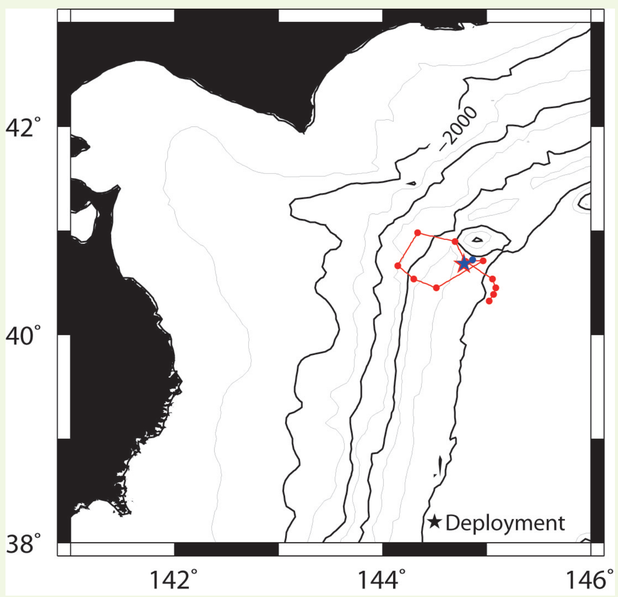
Maximum observing depth: 4000 dbar
(available in the whole ocean, covering about 90% of the ocean in volume)
Sensors: a SBE-CTD for deep float
Level / continuous sampling selectable
(DO sensor model under study)
Size: 210 cm and 50 kg (Max. Dia. 25 cm)
Two-way communication by Iridium SBD
Position is fixed by GPS
Lithium batteries

Preliminary results of a deep field test in August-September 2012

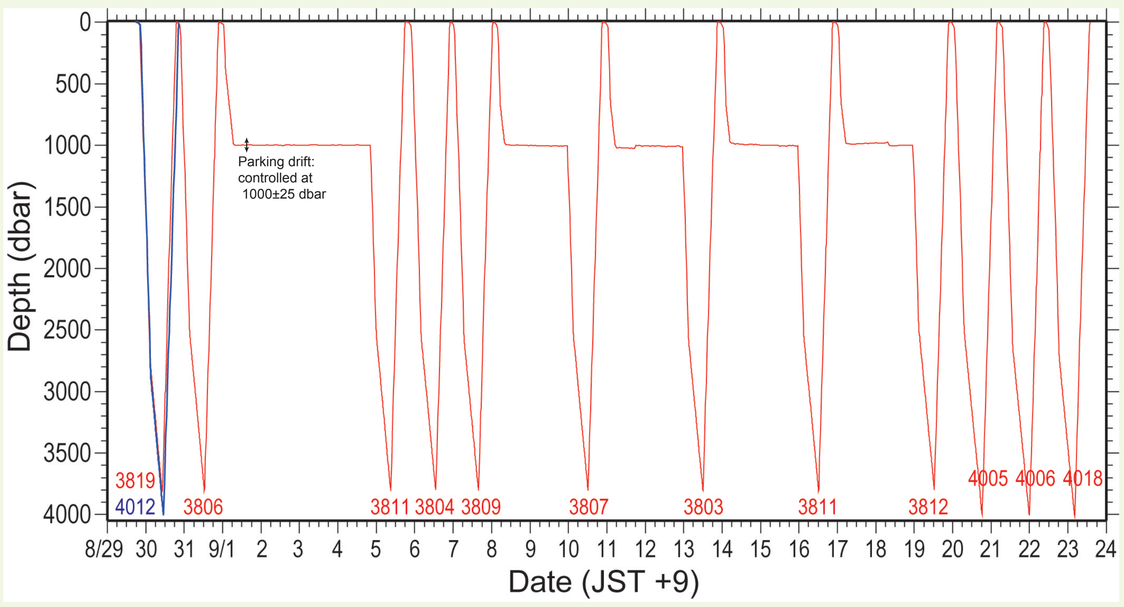
Two Deep NINJAs were deployed in deep water east of Japan from R/V Wakataka-maru (Fisheries Research Agency, Japan) on Aug. 29, 2012 to examine its total performance. They succeeded to measure CTD profiles from great depth (about 4000 dbar) and one of them (shown by red) has observed 12 deep profiles (including 3 profiles from >4000 dbar) until Sep. 24. The contact with the other (blue) was, unfortunately, lost after the first ascent from 4012 dbar, probably because of some failure in its communication unit. The field test for the red float will be continued until the end of Octorber and then it will begin an operation for deep monitoring.



Vertical profiles of theta (left) and salinity (middle) and T-S diagram (right) measured by Deep NINJAs.



Locations of Deep NINJAs fixed by GPS at sea surface.

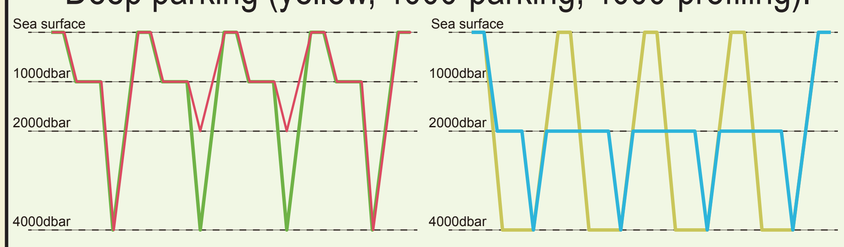


Vertical movements of Deep NINJAs below the sea surface. The period of observing cycle for the red float was changed from 5 days to 3 days by e-mail (see below).

Operation patterns available for Deep NINJA

Deep NINJA is designed to satisfy various demands of ocean observations from users. The standard operation patterns of Deep NINJA are

- Normal (green, 1000-parking, 4000-profiling),
- Energy saving (default setting: orange, 1000-parking, 4-2000-1-4000-profiling: figure shows 2-1 case),
- Deep parking (yellow, 4000-parking, 4000-profiling).



The blue pattern, observing deeper layers more frequently, is under development. Deep NINJA equipped with the pattern will be optionally ordered.

More flexible operation

To enhance the flexibility of ocean observation by Deep NINJA, the following parameters can be changed by E-mail commands even after deployment. The shown values will be set (as default) by TSK at shipping.

Period of observation cycle:	10 days
Depth of deep / shallow profiling:	4000 / 2000 dbar
Depth of parking:	1000 dbar
Frequency of deep profiling:	every 5 cycles
Cycle of 1st deep profiling:	0
Deep / shallow profiling ASAP:	Deep Yes
Interval of CTD sampling at parking:	12 hours
Switching level / continuous sampling:	Level
Start depth of continuous sampling:	(1000 dbar)
Interval of sampling bins:	(2 dbar)
Change into "Recovery mode"	
Interval of position data transmission:	(10 mins)

Avoiding death from sea ice

If Deep NINJA predicts sea ice at surface, it stops observation and descends promptly. The observed data are then transmitted when the float arrives at the surface next time. These functions are similar to ISA and iStore introduced by Klatt et al. (2007).

Avoiding groundings

If Deep NINJA guesses that it is on the sea floor,

it ascends by 50 dbar (changeable) above the floor in order to drift away from the shallow region (at parking or descending for parking).

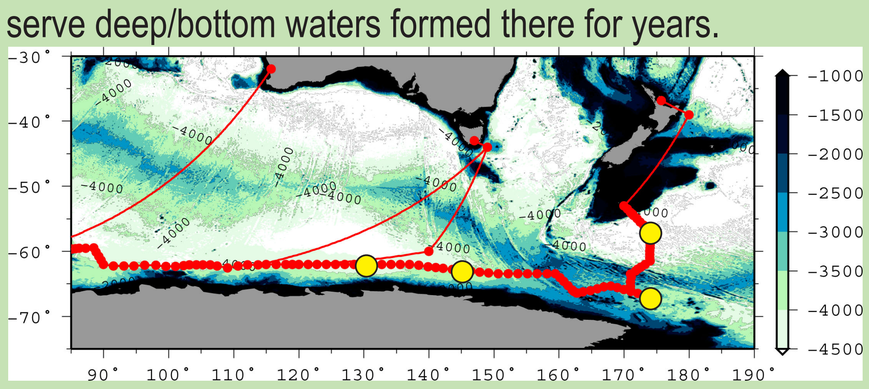
it begins ascending / profiling promptly (at descending for profiling).

Recording the float's cycle timming

Deep NINJA is programmed to record the timmings of Ascent start/end, Descent start/end, Deep Descent start/end, and Transmission start/end to estimate velocity at parking depth acculately.

Future Plans

4 Deep NINJAs will be deployed in the Indian sector of the Southern Ocean in 2012-13 winter from R/V Mirai to observe deep/bottom waters formed there for years.



Deep NINJA will be available for public in 2013.

If you are interested in Deep NINJA and observations with it, please ask TSK of more information about it.

Contact of TSK: sales@tsk-jp.com