

# The test of new mini AXBT and its possible mission in typhoon surveillance flight at western Pacific

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## Abstract

A mini type of AXBT (airborne expendable bathythermograph), similar size of Vaisala RD94 dropsonde, is designed by Taiwan researchers and keeps testing from 2013 to 2014. This mini AXBT (called DORIS) will be dropped delivered into the open ocean from Vaisala EM122 dropsonde launcher in Gulfstream-100 jet which serves dropsonde typhoon surveillance flights for 10 years in western Pacific region. DORIS weights 1.2 kg including 500m length of magnet wire thermistor with iron bullet anchor, parachute, Iridium satellite transmitter and battery package. It is also expected to play as a short-term drifter, too. This study shows the updated feature of DORIS and several field tests including water hit in diving pool, parachute performance in air and ~1000m depth temperature profile comparison over ocean with TSK T7 XBT and CTD measurements in TORI Ocean Research Vessel cruise.

## 1. Motivation:

The intensity of tropical storm (called Typhoon in Pacific region and Hurricane in Atlantic region) challenges research community and operation forecast a lot. Two recent field programs, TPARC/TCS08 in 2008 and ITOP in 2010, in western Pacific region try to collect data to answer this issue (Lin, et al., 2013). In these field campaigns, many airborne expendable bathythermographs (AXBT) were drop from P3 and C130 aircraft to collect the upper layer profile of sea water temperature. This temperature profile is the key factor to identify the maximum potential index (MPI) for typhoon intensification (Emanuel, 1988). A new index, OCPI (ocean coupling potential index), is proposed by Lin et al. (2013) and it needs the average water temperature between sea surface and the 26°C thermocline.

During 2003 to 2012, DOTSTAR project operated by Taiwanese scientists and Central Weather Bureau (CWB) had 64 surveillance flights (for 49 typhoons) with over 1000 Vaisala RD94 dropsonde from AIDC (Aerospace Industrial Development Corp.) Gulfstream-100 jet. This G100 Jet has no space to install U.S. Sippican or Japan TSK AXBT, and there is no this AXBT launcher in Taiwan Air Force KC130

aircraft. In order to improve the typhoon intensity forecast surrounding Taiwan and western Pacific region, three research institutes in Taiwan (NTU, TTFRI and TORI) proposed to make a mini AXBT for AIDC G100 jet. This mini AXBT (called DORIS, a sea nymph in Greek mythology) design starts from 2012 and had intensive function tests in 2013 and 2014. Section 2 will describe the features of DORIS, and some result of function tests will be presented in Section 3.

## 2. Feature of mini AXBT

In order to fitting Vaisala EM122 launcher in ADIC G100 carbine, DORIS has the 45-cm length tube shape with 6.5-cm diameter. This size dimension is similar to Vaisala RD94 dropsonde (Hook and Franklin, 1999). Drag parachute in 38 cm<sup>2</sup> square based pyramid is put in the upper sector to reduce the hit force of DORIS into the sea. For floating over sea surface, tube body is made by FRP (Fiber Glass Reinforced Plastics) and the middle (seal) sector with electronic board and batteries is sealed carefully for waterproof. 9602 Iridium transmitter is installed for sending temperature data, location and time back to the land. The bottom sector includes (1) a roller with ~500m length of magnet wire (2) an iron bullet anchor with Betatherm 5K3A1 thermistor (3) an iron ring holding 3-layer wafer paper which could be broken during hitting water and be dissolved for bullet drop. The total weight is about 1.2 kg and the material cost is about US\$800 per set.

## 3. Function tests on mini AXBT

### (1) the performance of parachute

In order to keep the cabin pressure and avoid the confliction on jet body during DORIS drop, the upper part of EM122 is a chamber in the cabin to keep the DORIS. When the top door of chamber closed and bottom door released, DORIS slides down vertically outside of the cabin along tube tunnel. The 38 cm<sup>2</sup> square based pyramid parachute of DORIS can't be opened until a safer distance away the aircraft. Two square holes besides parachute will allow air entering and expend the shape of pyramid shape. A model helicopter was used to test the opening and drag effect of the parachute in field from 200m height. This field test could be reviewed in Youtube link (<https://www.youtube.com/watch?v=fMz-lFIMg-0&feature=youtu.be> ).

### (2) the action of iron bullet during hitting water

The water-hit force and water resolving should be large enough to break the wafer paper installed on the bottom sector of DORIS. Then the iron bullet anchor could sink into the water and pull the ~500m length of magnet wire on the roller. This field test was done in the Taipei Public Diving Pool where has 10-m height tower with 5-m depth of water. The test could be reviewed through Youtube link

(<https://www.youtube.com/watch?v=u6bGOgr900A&feature=youtu.be> ).

### (3) the measurement of water temperature

Betatherm 5K3A1 thermistor was compared with Pt100 temperature probe in laboratory water tank first. The water temperature got warmer from 9 °C to 18 °C. The measurements by these two sensors gave same tendency and we found the Betatherm 5K3A1 thermistor has negative bias. Betatherm 5K3A1 thermistor with 1000m magnet wire was tested in the open ocean. It was deployed with TKS XBT T5 bullet and compared with a TKS T7 XBT and CTD device of Ocean research Vessel 5. The field comparison showed DORIS temperature profile has good consistent with these two common used tools, but the linear offset should be processed carefully. Fall Rate Equation and Coefficients of DORIS bullet is also needed to be tested and verified.

## 4. Conclusion

A mini AXBT (DORIS) designed by Taiwan researchers from 2012 and was tested for its different component in the past one year individually. The feature of this mini AXBT is suitable for Vaisala EM122 launcher in AIDC G100 Jet. After RD94 dropsonde launch, this mini AXBT will be dropped next to RD94 dropsonde to measure the ocean temperature profile under near- same location of atmospheric profile measured by dropsonde. DORIS is expected to provide OCPI information to improve typhoon intensity estimation. In 2014 summer season, DOSTAR project keeps its annual flights (~30 hours) for typhoon surveillance mission. DORIS will be arranged onboard to test its real performance in western Pacific Ocean.

## References:

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