

Original Paper

OCEAN OBSERVATION ON SST VARIABILITY AND SUB-SURFACE SEA WATER TEMPERATURE OF THE NORTH PAPUA THE FATE OF EL_NINO 1997 & 2007 AND LA NINA 2002 : FIELD MEASUREMENT AND TRITON BUOY DATA

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ABSTRACT

The increasing need to introduce and emphasis the analysis of SST and its sub-surface layers of deep water temperature (both horizontal and vertical) profile to analyze some oceanographic phenomena such as up-welling process and its relationship to its seasonal variability and spatial distribution was inevitable. Especially to avoid the misleading interpretation of using only sea surface temperature data for deep water fish biomass distribution analysis, etc. Field SST data of July – August 1997 was measured by CTD (Conductivity-Temperature-Depth) sensors on board of RV. BARUNA JAYA IV with accuracy of 0.01 °C. Field SST data of 2002 and 2007 was derived from TRITON Buoy data base with permission of Jamstec-Japan. All field and TRITON buoy SST data were processed into a spatial SST layer using Kriging method with Er_Mapper (Licensed user) software, and overlaid on the bathymetric layer. Average daily SST east monsoon 1997 (El Nino event) was 28.46°C, where as presumably La Nina event 2002 : the average daily SST was 29.75°C and for 2007 was : 29.83°C indicates a higher SST than both 1997 and 2002. Average daily SST of west monsoon 2007 was 29.69°C. Daily SST of 2007 east monsoon was about 0.08 - 0.5°C higher than the same season of 2002 (TRITON Buoy data). The paper analyze and revealed the fate / occurrence of up welling zone in adjacent of Halmahera islands as well as the Hot Event (HE) phenomena through the analysis based on multi-layer and sub-surface horizontal of both horizontal and vertical temperature of the field measurement 1997 and 2002 and 2007 TRITON data. Spatial multi-depth-layer approach had been developed in the paper is important for the analysis of deep water large pelagic fishery such as tuna fishery and its spatial distribution pattern.

Key words : sea-surface-temperature;North Papua;TRITON,El-Nino,La Nina

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INTRODUCTION

The need to introduce and highlight the analysis of deep water temperature (both horizontal and vertical) profile for oceanographical processes such as upwelling process and its relationship to fish biomass (small pelagic fish at the surface water and large pelagic in the deep water)

spatial distribution was inevitable. Especially to avoid the misleading interpretation of using only surface water temperature data for deep water fish biomass analysis (Hartoko, 2000a, 2000b, 2007). The pattern of seasonal surface current, as indicator of surface water movement had

been discussed by Wirtky (1961, 2005). One most relevant data was offered by the study of Kuroda *et.al.*, (1995) for the occurrence of North Guinea Coastal Under Current (NGCUC), but its effect to the development process of upwelling especially at adjacent of Halmahera islands was not yet known. The paper would especially analyze and discuss the sub-surface of horizontal temperature profile, which is not yet known and not developed yet to this matter before.

TRITON (*Triangle Trans-Ocean buoy Network*) was a series of oceanographic buoy built and set on the ocean by JAMSTEC (*Japan Agency for Marine-Earth Science and Technology*), used to measure marine meteorological and ocean surface parameters in order to monitor ENSO phenomena (*El Nino-Southern Oscillation*). Parameters measured by TRITON are wind speed, air temperature, humidity, rain precipitation, short wave solar radiation, sea surface temperature, current and water salinity. Especially for sea water temperature were also measured vertically to the depth of 500m (www.jamstec.go.jp). Measured data which was recorded in the sensor of TRITON then transmitted to satellite and distributed to researcher all over the world. There were at least about 18 TRITON buoys had been deployed by JAMSTEC on the West Pacific Ocean and East Indian Ocean. Data management of TRITON buoy consist of four parts. Physically there were four cylinders floating on the water surface which are data processing, data transmitter ARGOS (*Array for Geostrophic Oceanography System*), and two units of battery. Surface meteorological data transferred into the data processing and stored internally. Deep water data were transmitted from each sensors in the data processors with magnetic induction method by a telegraphic wire in the water (<http://www.jamstec.go.jp>).

MATERIALS AND METHODS

In-situ data of 1997 was a part of Fish Stock Assessment Expedition by RV. Baruna Jaya IV (BPPT) Length Over All : 60.4m; 1200GT, on June – August 1997 of North Papua. Both horizontal (surface water) and vertical temperature data was measured using CTD with 0.01 degree Celsius accuracy. GPS coordinate recorded every 6 minute interval. Design of survey track was 'U' parallel grid track ranged from 120 - 240 mile of North Papua with 60 interval between the main-leg, with total length of 3375 mile survey track (Johannesson and Mitson, 1982 and MacLennan and Simonds 1992 in Nugroho *et.al.*, (1996; **Fig.1**). Field CTD data were processed using 'Kriging' method using Er-Mapper software (licensed user). Analysis of horizontal temperature data approached with a multi-layer spatial analysis method developed earlier (Hartoko and Helmi, 2004).

The 2002 and 2007 in-situ data of sea surface and vertical temperature of sea water were measured by TRITON buoy using Conductivity, Temperature and Depth (CTD) thermometer sensor of MicroCAT, SBE37-IM attached underwater at the depth of 1 meter up to 500 meter. This thermometer sensor using Titanium for the sea water temperature measurement manufactured by *Sea Bird Electronic* with temperature accuracy of 0,002 °C (<http://www.jamstec.go.jp>).

Sea water temperature data of the TRITON buoy was split into two parts, that is days and hour data, for daily data was sampled at every 09.00 in the morning of East Indonesian Time (about 00.00 UTC). Water temperature data that transmitted by ARGOS were stored in ASCII data package that later downloaded and processed with Windows operations. The distribution of 9 TRITON buoy used in the study as indicated on **fig 1**.

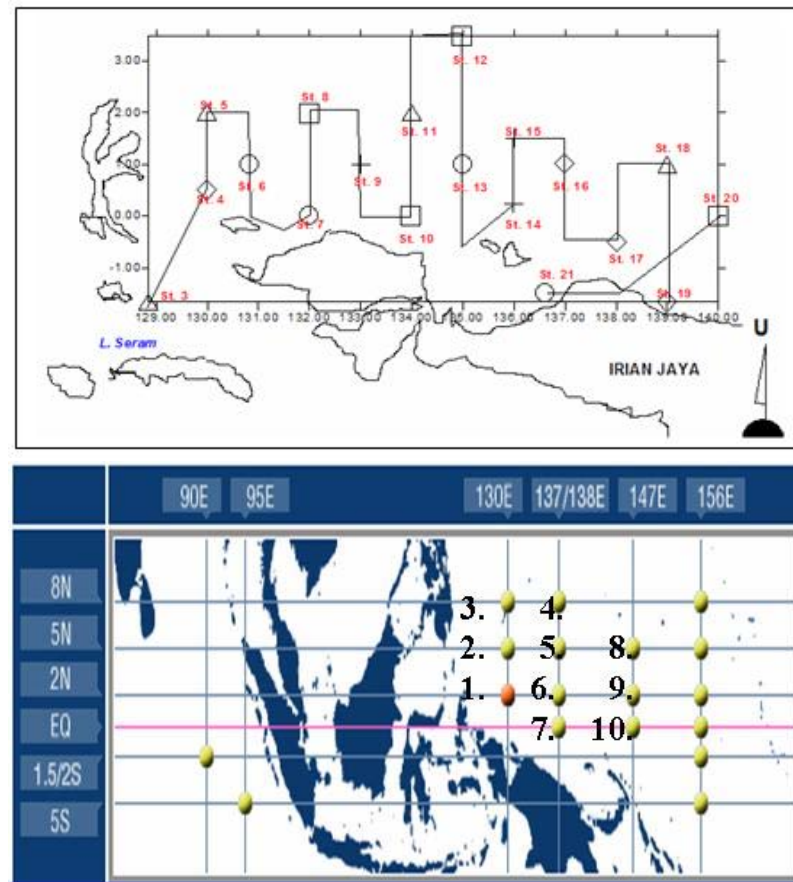


Fig 1. Map of in-situ CTD measurement stations by RV.BARUNA Jaya IV 1997 Expedition (above) and TRITON buoy used in the study(below)

RESULT AND DISCUSSION

Analysis on in-situ data measured during cruise of RV BARUNA JAYA IV on July – August 1997 of North Papua, the average daily SST of East Monsoon 1997 (commonly believed as El Nino event) was 28.46°C. The sea surface temperature range from 27.408 – 30.479 °C, and sea water temperature at depth of 80m range from 25.349 - 31.079 °C as indicated in Fig 2.

Previous paper (Hartoko, 2000, 2000a, 2004) had analyzed and revealed the occurrence of upwelling zone in adjacent of Halmahera Islands based on the analysis of both multi-layer horizontal and vertical temperature profile as indicated on Fig 2.

Where the water mass with temperature of 27 °C from depth of 80 – 100m from the North Papua flows vertically onto the surface layer at the upwelling zone at corridor between Halmahera Island and West Papua Peninsula (Hartoko,2000a; 2007). The most relevant data was offered by the study of Kuroda *et.al* (1995) for the occurrence of North Guinea Coastal Under Current (NGCUC), but its effect to the development process of upwelling at North Papua waters adjacent of Halmahera Islands was not known yet since. As performed on the SST 1997 was clearly indicated the occurrence of high sea water temperature which was later recognized as Hot Event (HE) by Kawamura *et al.*, (2008), where in

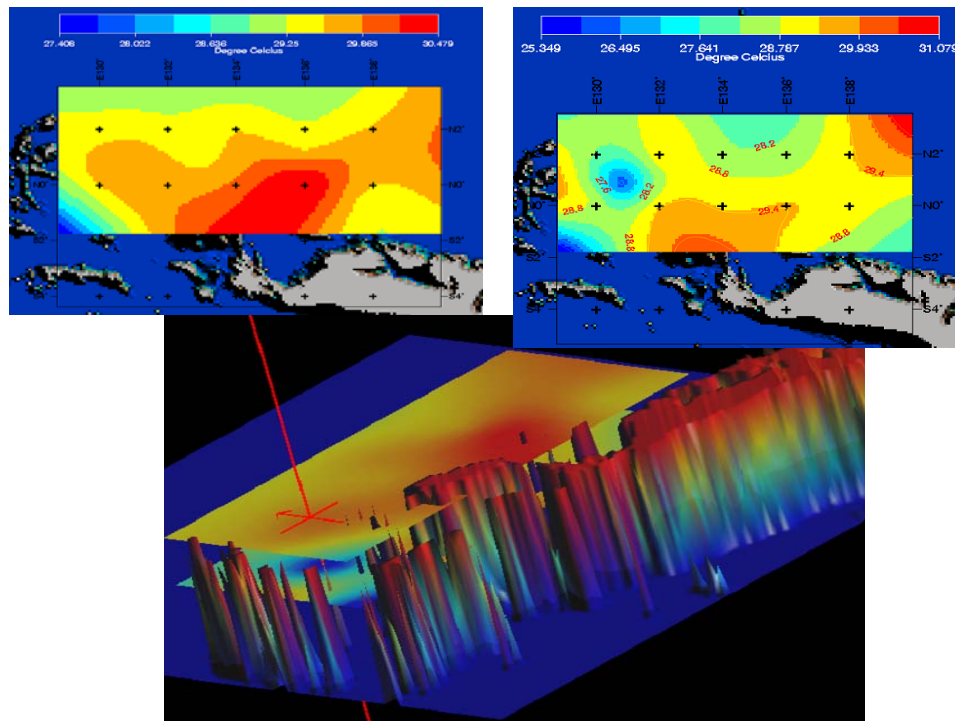


Fig 2. Sea surface temperature and sub-surface temperature at 80m depth East Monsoon 1997 (El-Nino event). Field measurement. BARUNA JAYA IV Expedition. (Arrow on the horizontal temperature graph is always point to North).

that special condition of HE regularly generates the sharp gradient of daytime vertical temperature profile in the near-surface layer (i.e. warm layer). Another supporting information as recorded SST from December 1996 to June 1997 indicated

the flow of hot water from the west of Peru flows along the equator to the North of Papua (West end Pacific) on global SST released by TOPEX Poseidon Jet Propulsion Lab (NASA,1997). This hot water mass contribute to 1°C SST increase/ anomaly.

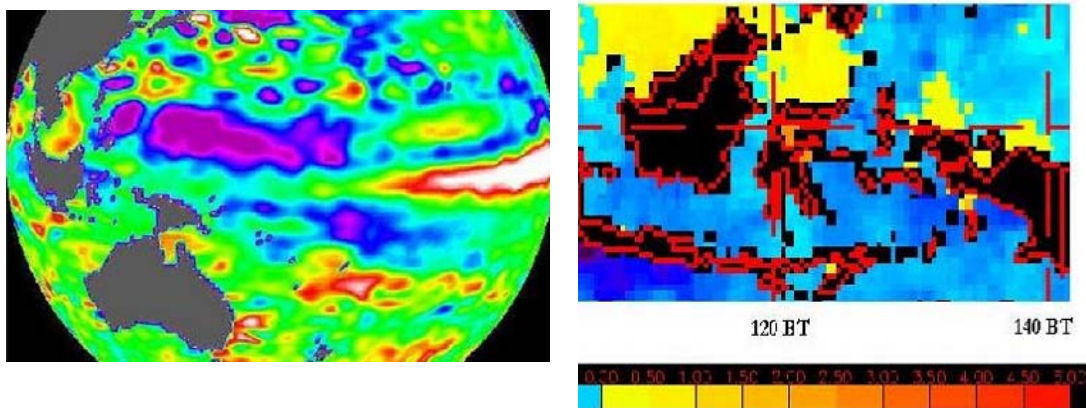


Fig 3. Hot sea water flows and SST anomaly on Global SST released by TOPEX Poseidon Jet Propulsion Lab (NASA,1997).

In line to the above case Gordon (2005) confirmed that large scale of Indonesian Through Flow (ITF) was the flow of Pacific water along the equator westward into the Indian Ocean via the Indonesian seas, with primary ITF portals flow westward along the North coast of Papua. Especially passes through Halmahera – Papua corridor later known as South Pacific inflow or South Pacific thermocline where it first upwelling into the surface layer before spreading southward within the surface Ekman layer, as revealed earlier in Hartoko (2007). Analysis on in-situ sea water temperature derived from TRITON buoy data at La Nina event 2002 : the average daily SST at East Monsoon (July – November 2002) was 29.75°C, with temperature range from 28.3 - 31.3 °C. Furthermore, with a multi-layer special analysis method had revealed and clearly detected that ‘hot-event’/ HE not only on the SST but also can be found in its sub-surface layers at the depth of 50m, 100m, 150m (which was measured by each sensors of TRITON at each depth), flowing along the coast, with high sea water temperature range from 29 – 30.5 °C. Average of sea surface temperature (average of daily and monthly TRITON data) in 2007 was 29.83°C indicates higher SST than both SST of 1997 and 2002. Average daily SST of West Monsoon 2007 (December 2006,

January and February 2007) was 29.69°C (**Fig 6,7,8,9**) . The increase of daily SST of 2007 East Monsoon (July – September 2007) was about 0.08 - 0.5°C higher than same season of 2002 (TRITON Buoy data).

The fundamental concept of the paper was that both vertical and horizontal of seawater temperature was the indicator for seawater mass movement. In general view, the horizontal SST pattern was always assumed as the indicator for horizontal water movements, but in fact based on the multi layer sub surface horizontal temperature revealed in this study is that there were some differences of horizontal pattern of sea water temperature profile at each layer depth (**Fig 2**). Any specific pattern of seawater temperature profile differences on each depth layers is an indicator of the water mass movement, latter on had been identified also acting as the horizontal distribution of nutrient such as nitrate, phosphate etc will be affected by horizontal water mass movement. Furthermore, on the other case such as in the case of upwelling process, a vertical movement of the water mass would be the dominant factor for the vertical spatial distribution of nutrient rather than horizontal water flows (performed by three layer nitrate-phosphate-chlorophyll-a RGB-spatial interaction model, (Hartoko, 2010 in press).

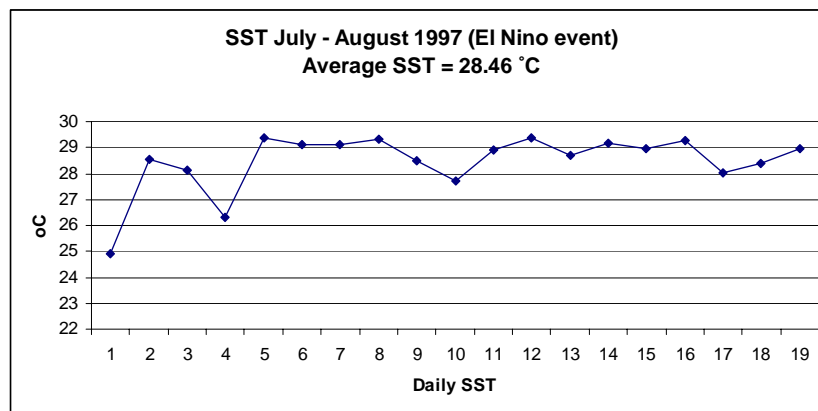


Fig 4. East monsoon SST (July – August 1997) North Papua, field data measurement CTD – RV.BARUNA JAYA IV

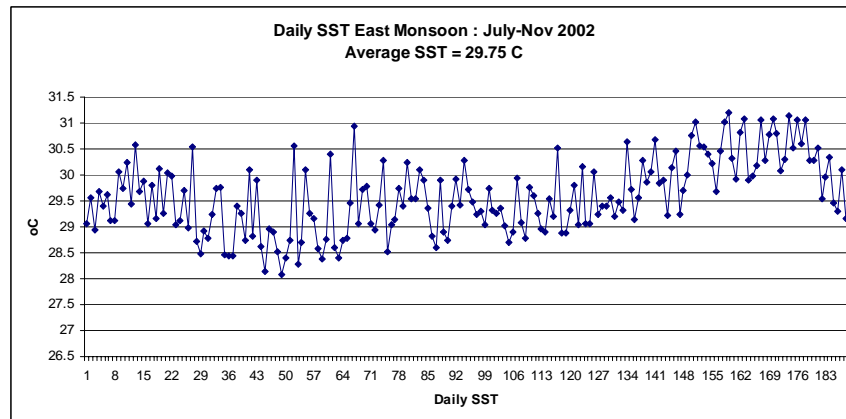


Fig 5. East Monsoon SST (July – November 2002) North Papua, TRITON data

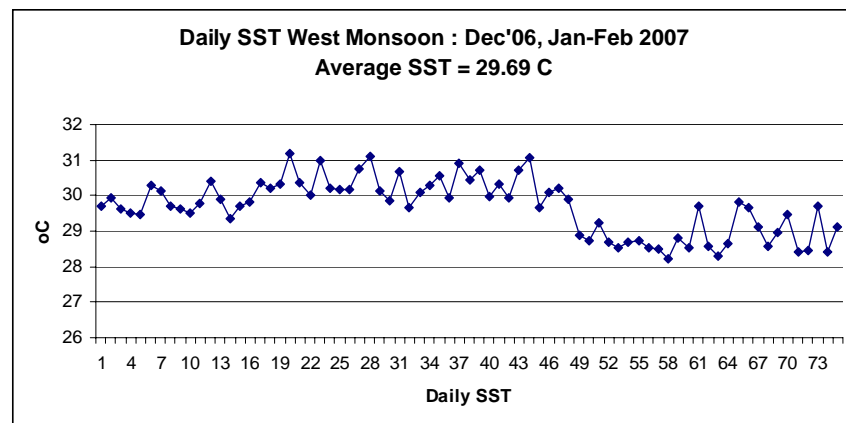


Fig 6. West Monsoon SST (Dec '06, Jan – Feb 07) North Papua, TRITON data

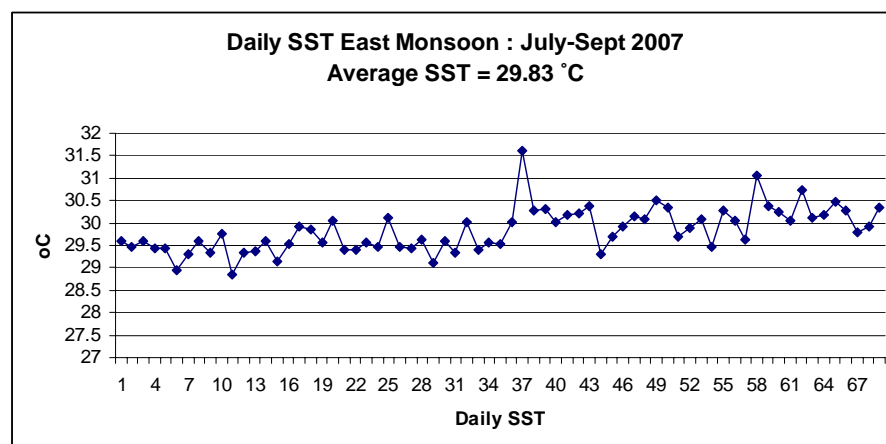


Fig 7. East Monsoon SST (July - September 2007) North Papua, TRITON data

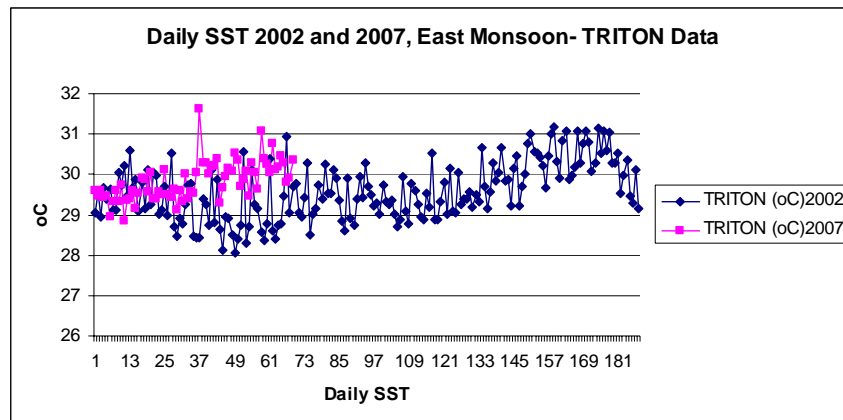


Fig 8. Average daily SST of East-Monsoon 2002 and 2007 (TRITON data)

Based on TRITON Buoy data (**Fig 6,7,8**) leading into a conclusion, that the SST increase between El Nino (1997) to La Nina event (2002) was about 1.29°C (from 28.46°C to 29.75°C). Increase of average daily SST of east monsoon 2007 was about 0.08 - 0.5°C higher than the same season of 2002.

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