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Pusat Riset Wilayah Laut dan Sumberdaya Nonhayati
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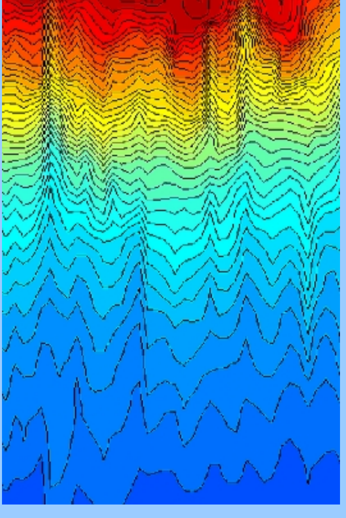

Argofloat Temperature profiles

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Jurnal Ilmiah
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SEGARA Volume I terdiri dari 4 nomor, merupakan edisi perdana yang berisi sebagian dari hasil riset kerjasama *International Nusantara Stratification and Transport* dibidang oseanografi. Jurnal ini diasuh oleh Pusat Riset Wilayah Laut dan Sumberdaya Nonhayati, Badan Riset Kelautan dan Perikanan – DKP, dengan jadual penerbitan satu volume setiap tahunnya dengan tujuan menyebarluaskan informasi ilmiah tentang perkembangan ilmiah bidang kelautan di Indonesia, seperti : oseanografi, akustik dan instrumentasi, inderaja, kewilayahan, sumberdaya nonhayati, energi, arkeologi bawahair dan lingkungan. Naskah yang dimuat dalam jurnal ini terutama berasal dari hasil penelitian maupun kajian konseptual yang berkaitan dengan kelautan Indonesia, yang dilakukan oleh para peneliti, akademisi, mahasiswa, maupun pemerhati permasalahan kelautan baik dari dalam dan luar negeri.

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Redaksi menerima tulisan/makalah dari para peneliti dan praktisi dibidang Wilayah Laut dan Sumberdaya Non Hayati Laut maksimal 5 halaman A4 dengan spasi 2. Redaksi berhak mengubah naskah sepanjang tidak merubah isi kandungan karya ilmiah. Tanggung jawab isi tulisan terletak sepenuhnya pada penulis. Silakan kirim tulisan beserta identitas diri ke nomor telepon seperti tersebut diatas atau ke alamat email; tisiana@dkp.go.id

UPWELLING EVENT 2003 ALONG SOUTH JAVA SEA AND LESSER SUNDA ISLANDS

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ABSTRACT

Southeast Indian Ocean consist tropical and sub-tropical. The Indian Ocean part of South Java Sea and Lesser Sunda islands is a tropical area that the upper layer water mass continuously receives enough sunshine all year around and this event happens mainly because of the Sun height above Indonesian archipelago is hardly change over the year. This part of Indian Ocean is also influenced by the Monsoon and inter-seasonally divided.

Previous scientist found that upwelling event is consequence with interannual atmosphere-ocean teleconnections. Upwelling and downwelling event can indicating by shallowing and deepening the thermocline layer. Thermocline layer which mention in above, likely Ekman pumping phenomenon and Kelvin wave penetration is really happened along South of Java waters and South of Nusa Tenggara waters. The existence of downwelling and upwelling are shown clearly using Argo Floats data. During El Nino, upwelling developed by Indonesian Trough-Flows (ITF) transports colder water which shallowing thermocline depth, stronger easterly wind suppresses coastally trapped Kelvin waves, and monsoon transition. Conversely, upwelling intensity is reduced by ITF which transports warm water during La Nina periods.

We used mainly data temperature acquired using Argo Float 2002 - 2004 in South of Java Sea, Lesser of Sunda & Southeast Indian Ocean (5°S - 17°S and 100°E - 130°E). There are 11 floats in that region which number WMO-ID: 53547, 56510, 5900026, 5900027, 5900032, 5900033, 5900034, 5900036, 5900037, 5900043, and 5900045. We also use remote sensing data sets as supports which provided by CSIRO

Marine Labs in Hobart, Tasmania such as wind data provided by Quikscat 6 hours average (5°N-15°S and 80°E-130°E), Ocean Colour from SeaWifs, and sea surface temperature (SST) from NOAA-AVHRR.

Since 2002, Agency for Marine & Fisheries Research under Ministry of Marine Affairs and Fisheries The Republic of Indonesia has implementation agreement with CSIRO Australia about ocean research using Argo Floats. In September 2002, we put 2 Argo Floats in South Java Sea and Sea of Lesser Sunda Islands.

Keywords: *Thermocline, Temperature, Argo Floats, Upwelling, Downwelling*

1. INTRODUCTION

Southeast Indian Ocean consists tropical and sub-tropical (Tomczak & Godfrey, 1994). The Indian Ocean part of South Java Sea is a tropical area that the upper layer water mass continuously receives enough sunshine all year around and this event happens mainly because of the Sun height above Indonesian archipelago is hardly change over the year. This part of Indian Ocean is also influenced by the Monsoon (Wyrtki, 1961) and inter-seasonally divided (McBride, 1992 *in* Ningsih, 2000).

Previous scientist found that upwelling event is consequence with interannual atmosphere-ocean teleconnections. Upwelling and downwelling event can indicating by shallowing and deepening the thermocline layer. Thermocline layer which mention in above, likely Ekman pumping phenomenon and Kelvin wave penetration is really happened along South of Java waters and South of Nusa Tenggara waters. At the normal years, upwelling developed from early June to mid-October start off the east of southern coast of Java and then moves Northwestward to 104°E at speed of 0.2 m/s due to alongshore wind and latitudinal changes in the Coriolis parameter. During El Nino, upwelling developed by Indonesian Through-Flow (ITF) transports colder water which shallowing thermocline depth, stronger easterly wind suppresses coastally trapped Kelvin waves, and monsoon transition. Conversely, upwelling intensity is reduced by ITF which transports warm water during La Nina periods (Susanto, *et al.*, 2001).

Southern Sea of Java, Bali, Nusa Tenggara are the potential upwelling location, which usually happens in East Monsoon in July, August and September (Nontji, 1993; Purba, *et al.*, 1993; Hendiarti, *et al.*, 1995; Hendiarti, *et al.*, 2004; Susanto, *et al.*, 2001; Moore & Marra, 2002). Pond and Pickard (1995) also showed that around 90%

of the world's catch location is occupied only about 2 - 3% of the entire ocean and mainly in the upwelling area. Specifically, in along Southern coast of Java-Bali-Nusa Tenggara waters is the Tuna Catch area, which has production in 1992-2000 about more than 186,412 tonnes (Statistic of Capture Fishery Indonesia, DGCF *in* Proctor, *et al.*, 2001).

2. DATA SETS

We used mainly data temperature acquired using Argo Float 2002 - 2004 in South of Java Sea, Lesser of Sunda & Southeast Indian Ocean (5°S - 17°S and 100°E - 130°E). There are 11 floats in that region which number WMO-ID: 53547, 56510, 5900026, 5900027, 5900032, 5900033, 5900034, 5900036, 5900037, 5900043, and 5900045. We also use remote sensing data sets as supports which provided by CSIRO Marine Labs in Hobart, Tasmania such as wind data provided by Quikscat 6 hours average (5°N-15°S and 80°E-130°E), Ocean Colour from SeaWifs, and sea surface temperature (SST) from NOAA-AVHRR.

3. RESULTS & DISCUSSION

Thermocline layer, likely Ekman pumping phenomenon and Kelvin wave penetration is really happened along South of Java waters and South of Nusa Tenggara waters. The existence of downwelling and upwelling are shown clearly using Argo Floats data. During El Nino, upwelling developed by Indonesian Trough-Flows (ITF) transports colder water which shallowing thermocline depth, stronger easterly wind suppresses coastally trapped Kelvin waves, and monsoon transition. Conversely, upwelling intensity is reduced by ITF which transports warm water during La Nina periods. The affect of Kelvin waves to the temperature can be seen because the thermocline fluctuate in along the year and inter-annually (see **Figure 1**).

We have been already know that upwelling will bring cold water mass and nutrient from certain deepness to the surface, conversely downwelling will bring mass from the shallow to the deep, and if downwelling happened at the time of algae blooms hence possibility the chlorophyll-*a* concentration will lessen on the surface of along South of Java waters and South of Nusa Tenggara. Eddy currents also have potency to lessen the amount of Chlorophyll-*a*, such as which have been reported by Garcia, *et al.* (2004).

Floats 5900026 which floating around in near Sumba island can be used for represent of upwelling and downwelling and its relation with Chlorophyll-*a* distribution (see **Figure 1**). For instance, when we look at to the Chlorophyll-*a* distribution pattern and thermocline layer pattern during August 2003, likely downwelling not very influence to amount of the Chlorophyll-*a*. Shown that at the mid of July upwelling happened, followed by downwelling in the early August, then upwelling return at near end of August, during that period the amount of chlorophyll-*a* not many changing. This matter happened probably because Chlorophyll-*a* at that time very abundance (blooming), sun energy in tropical sea can penetrating enough to the water deep, and wind only weakening just at a moment so mixed layer have a little time to shallower. The possibility of Kelvin wave influence to reduction of Chlorophyll-*a* amount on the surface can be happened in October 2003, where if we look at the early October 2003 there's very strong downwelling happened with penetration can reach more than 400 meters depth (see circle black dash line in **Figure 1**), furthermore that event to be followed by decreasing of Chlorophyll-*a* amount on the surface at mid of October then its disappear when coming near end of October.

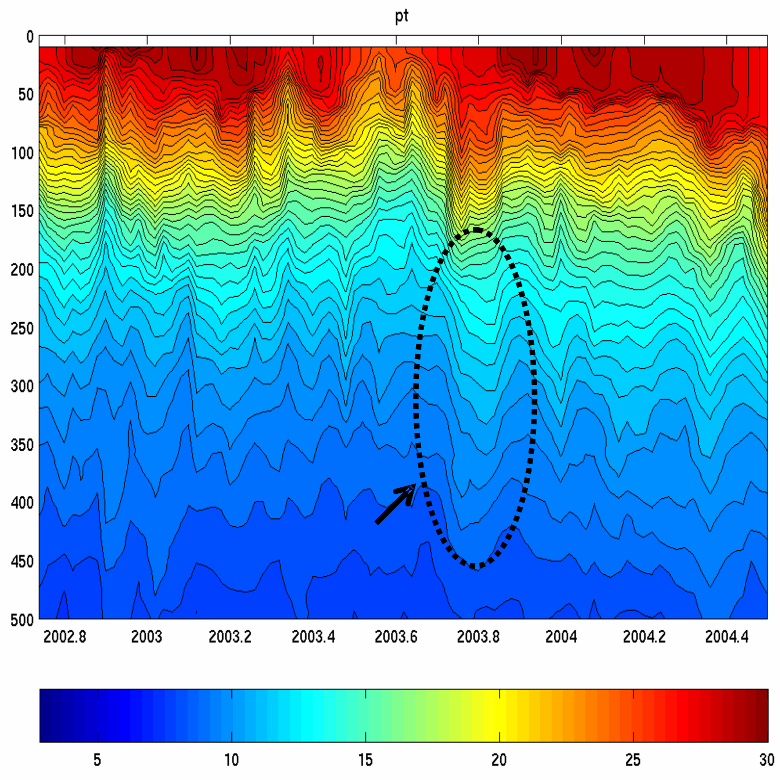

Figure 1. *Temperature profiles from floats 5900026 (x line = decimal years, y line = depth)*

We think that upwelling and downwelling event also existing currents eddy are very influence (supports) to the stability of fishing ground in Southeast Indian Ocean in general and particularly in South of Java waters (see **Figure 2**). Where Eddy currents will transport Chlorophyll-*a* from along South of Java waters to Southeast Indian Ocean, then the downwelling event will sink the Chlorophyll-*a* go to certain deepness, where the habitat of tuna exists. According to some fisheries report, some species of tuna which important commodity (commercial) to Indonesia, Australian, and Japan having habitat in Southeast Indian Tropical Ocean (Collete & Nauen, 1983; Caton, 1991; Proctor, *et al.*, 2001). Where, tuna habitat has been recorded by some previous scientist that like Southern Bluefin Tuna live in ~50 meters depth range, Yellowfin Tuna live in 1-250 meters depth range, Albacore in 0-600 meters live depth range, and Skipjack Tuna live in 0-260 meters depth range (Collete & Nauen, 1983; Caton, 1991). And then the newest information from Fisheries division of CSIRO Marine Research, who develops technology of archival tuna tags since 1993, is that Southern Bluefin Tuna can swim till 300 meters depth (see **Figure 3**). It showed that it make sense if the downwelling event which can reach more than 400 meters depth can provide food for the tuna which live in the depth water.

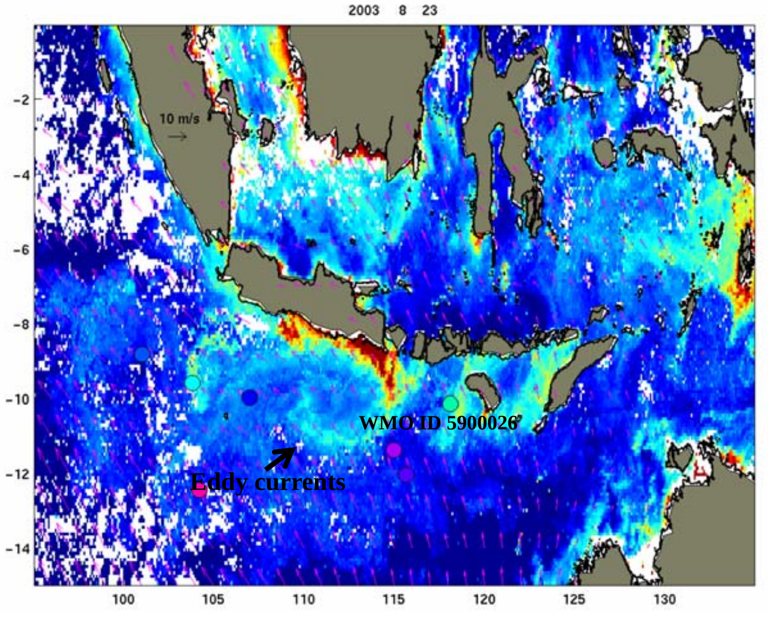

Figure 2. *Edy currents pull the chlorophyll-a from south coast of java to the sea (Dots = Argo Floats, Arrows = wind speed & direction)*

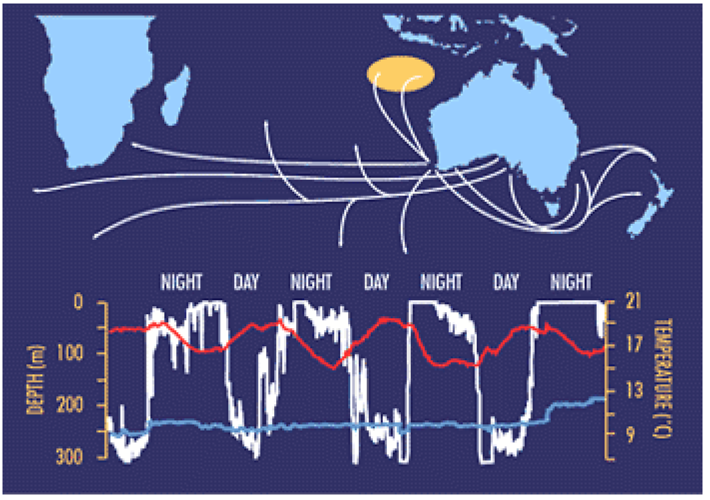

Figure 3. *Southern Bluefin Tuna migration.* ***(Top)*** *Southern Bluefin Tuna geographical migration with spawning area "yellow ellips" in Southeast Indian Ocean,* ***(Bottom)*** *Archival tags have taught scientist much about tuna swimming depth "white line", body temperature "red line" and water temperature "blue line" on a day/night cycle.*

The distributions pattern of sea surface temperature likely is similar with monsoon periods which happened in Indonesian archipelago. And then distributions pattern of Chlorophyll-*a* associated with distributions pattern of sea surface temperature. Sea surface temperature around South of Bali waters and South of Nusa Tenggara waters develop to cold started at around March and at the same time at the periods is Chlorophyll-*a* emerge / appear, but appearance of the Chlorophyll-*a* just till mid of May. The cold water then expands / moving up to west during June till August, with peak of cold water appearance covering along South coast of Java waters happened when coming near mid of August. The appearance of Chlorophyll-*a* also seen covering along South of Java waters and South of Nusa Tenggara waters at June till October, where highest intensity seen at June. This matter happened probably because of the nutrient which brought by upwelling to the surface will need certain time for used by phytoplankton growth.

We think that if seen from existing pattern of when the Chlorophyll-*a* in high intensity and when the upwelling comes up, the lags time is about 1.5 - 2 months. And then at November (switchover period from cold water to warm water) and December (warm water period) seen there're no Chlorophyll-a along South of Java Sea and South of Nusa Tenggara waters, but there are some dot spot apparition of Chlorophyll-*a* in South coast of Java waters at January-February though at that moment its condition is warm water. The mentioned happened probably because in the area there are a lot of big river bringing a lot of nutrient from mainland to the estuarine waters when rainy season, so it is not happened because of sea surface temperature affect (no directly influence from sea-air interaction).

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