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**A UNIQUE CYCLONIC AND ANTI-CYCLONIC EDDIES
CURRENT CHARACTER IN BANDA SEA**

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ABSTRACT

A unique cyclonic and anti-cyclonic Eddies in Banda sea has been intensively studied using the data model from Infrastructure Development for Space Oceanography (INDESO) recorded from June 2010 to May 2011. According to our computational analysis, we found that **the cyclonic of the Banda Sea happened in 12 days in January 2011. While the anti-cyclonic was observed as long as 111 days from June to September 2010.** The unique phenomena were closely connected to 3 main factors: sea surface height, temperature, and salinity. The detail relationships among the physical parameters are discussed. This unique process of cyclonic and anti-cyclonic was happened during LaNina year in 2010 to 2011. This present work suggests that anti-cyclonic behavior of Banda sea during La Nina has a much longer time than that for cyclonic due to the meeting of 2 powerful currents from Indonesia Through Flow (ITF) coming from Halmahera sea, and Flores sea.

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INTRODUCTION

Cyclonic and anticyclonic eddies [1] are a typical ocean phenomenon caused by few important physical parameters such as a complex interaction between the wind above a sea and the sea current due to different temperature and salinity, the surface topography of the islands surrounding a sea [2], and the existing vortices which caused multiple eddy cells [3]. Furthermore, there were many different cases of such interactions between cyclonic and anticyclonic eddies that needed to have further studies and observation with a more sophisticated technique, for instance the productive mesoscale cyclonic eddies [4], the interaction between the physical and biological conditions in the eddies sea area associated with the nutrient transportation in such rich water full with NO₂ and NO₃[5], and highly contaminated atmosphere above the ocean caused by toxic gases such as CO₂ and CO that directly made ocean acidification closely connected with a major threat to the large scale of ocean organisms [6].

On the other hand, the interaction of cyclonic and anticyclonic eddies may have been caused by a complex wind and sea water content interactions signed by a season or weather changing, for examples: the process of monsoon dynamics in Indian ocean [7,8], multi-decadal ocean variability in Atlantic ocean [9] and climate-forced variability in ocean hypoxia [10], as well as tropical climate variability in Indian ocean [11]. Such interesting nature phenomenological behaviors are attractive to be investigated in the near future.

In present paper, a unique cyclonic and anticyclonic Eddies current character in Banda sea is carefully studied by using the data model from Infrastructure Development for Space Oceanography (INDESO) recorded from June 2010 to May 2011. According to our computational analysis, we found that the cyclonic of the Banda sea happened in 12 days in January 2011. While the anti-cyclonic was observed as long as 111 days from June to September 2010. The

unique phenomenas were closely connected to 3 main factors: sea surface height, temperature, and salinity. The detail relationships among the physical parameters are intensively discussed.

COMPUTATIONAL METHOD

The simulation and computational method provided in this study were based on the data recorded from June 2010 to May 2011 by INDESO, a collaborative project between France and Indonesia during the interval time of about 7 years. The original data was then organized with the use of common softwares called as Microsoft excel and origin. All the plotted data were then analyzed and figured out by using Ocean Data View 4. The obvious computational oceanography images were further drawn, and investigated carefully figure by figure. To fully master the scientific findings, a big view of cyclonic and anticyclonic phenomena in Banda sea are intensively studied with all possibilities links closely related to it. This computational research system can proceed a unique character finding in cyclonic and anticyclonic eddies based on our physical study.

RESULTS AND DISCUSSION

Figure 1 shows that a unique process of anticyclonic eddy happened in a deep Banda sea as long as 111 days from exactly 4th June to 22nd September 2010. Such attractive anticyclonic eddy made a down-welling process in the sea, for instance as shown in the inset of Fig. 1 recorded based on computational data on 6th August 2010. The diameter size of anticyclonic eddy was getting bigger 1 month later after the 6th of August. Furthermore, 16th days later from such observed moving anticyclonic from the south to the north part of Banda sea or on 22nd September 2010, the anticyclonic was gradually disappeared.

Anti-cyclonic Eddy current character in Banda sea

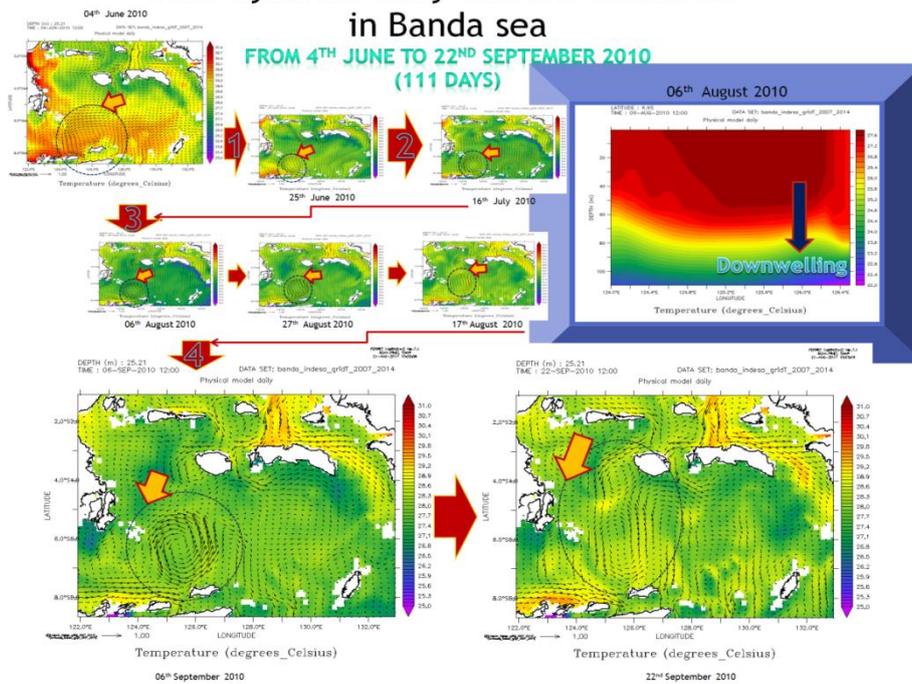


Figure 1. The 111 days unique character of anti-cyclonic Eddy current in Banda sea. The inset explains downwelling temperature behavior of an anti-cyclonic eddy, for example recorded on 6th August 2010.

On the other way around, the cyclonic eddies were happened shortly within 12 days only. Such unique process and transformation of ocean physical phenomenon is depicted briefly in Fig. 2 as many as 11 steps. It is interesting to note that these 3 eddies were observed ~4 months after the presence of anticyclonic eddy or from 20th to 31st January 2011. The reason of

such unique eddies was due to upwelling process, for example as shown in the inset of Fig. 2 computed on 27th January 2011. In addition, the first vanished cyclonic among the three was the former cyclonic, while the second and the third ones were disappeared later on in three different interval of time, respectively.

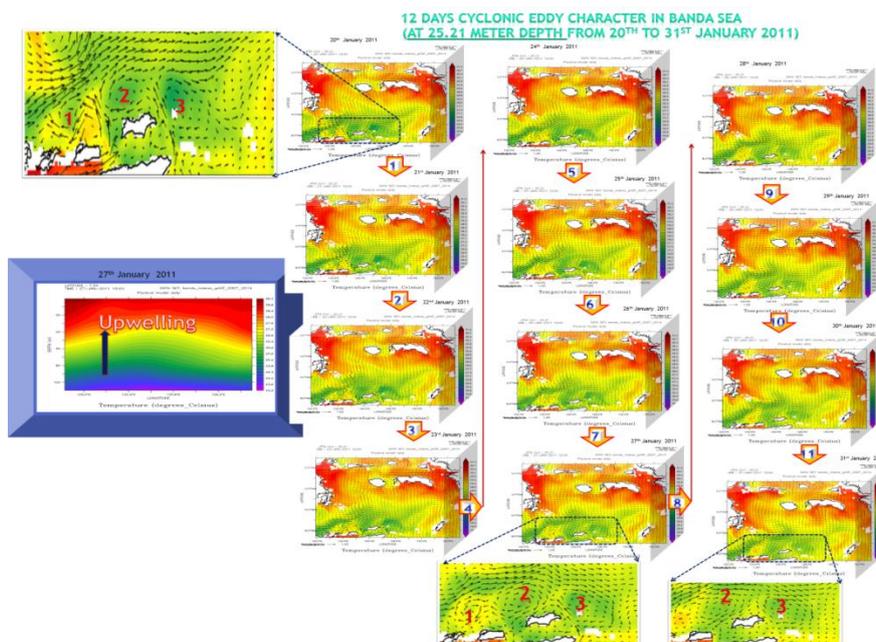


Figure 2. The 12 days unique character of cyclonic Eddies current in Banda sea. The inset with blue color frame shows the significant indicator of upwelling temperature process in the three cyclonic eddies in Banda sea, for example on 27th January 2011.

The observation of these unique anticyclonic eddy and cyclonic eddies were different from many cases which had been investigated by various scientists [1-6]. Such different physical behavior may be due to the circumstances of deep Banda sea which is as deep as ~7000 m much deeper than that in Indian and Atlantic oceans, respectively. Moreover, the eddies current was indicated in south west monsoon during La Nina 2010 to 2011 [12]. In order to have a more detail explanation, we suggest a further investigation in these complex anticyclonic and cyclonic eddies in different interval of time in such deep Banda sea. However, based on our results clearly described in Fig. 1 and Fig. 2, such different interval of time anticyclonic and cyclonic eddies were caused by at least 3 main reasons such as sea surface height, temperature, and salinity simulated in the inset of Fig. 1 and fig. 2 about the down-welling process during anticyclonic eddy and upwelling process in cyclonic eddies.

CONCLUSION

In summary, the observation of unique behaviors in anticyclonic and cyclonic eddies happened in a deep Banda sea were obviously only within 4 months from the occurrence of anticyclonic eddy to cyclonic eddies. The typical character was identified with a long term occurrence of anticyclonic eddy which was 111 days or 105 days longer than that in cyclonic eddies. Such big different in time of the two different eddies was due to the number of cyclonic eddies about 3 times more than the anticyclonic eddy. Therefore, a single anticyclonic eddy unique character had made it a much longer process in comparison with that in cyclonic eddies. The cyclonic eddies caused an upwelling process in the Banda sea, while the anticyclonic eddy caused a down-welling phenomena in the sea.

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