

Characteristics of Halmahera Eddy and its relation to sea surface temperature, Chlorophyll-a, and Thermocline layer

by Anindya W

Submission date: 27-Sep-2022 09:50AM (UTC+0700)

Submission ID: 1910040803

File name: f_Halmahera_Eddy_and_its_relation_to_sea_surface_temperature.pdf (3.22M)

Word count: 4777

Character count: 24077

PAPER · OPEN ACCESS

Characteristics of Halmahera Eddy and its relation to sea surface temperature, chlorophyll-a, and thermocline layer

To cite this article: Muhammad Firdaus Ramadhan *et al* 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **530** 012039

View the [article online](#) for updates and enhancements.

You may also like

- [Social Conflict in Malifut Sub-district of North Halmahera Regency](#)
Ebin E Darius

- [The food composition of Halmahera walking shark \(*Hemiscyllium halmahera*\)](#)
Y Jutan, A S W Retraubun, A S Khouw et al.

- [Coulomb stress analysis of West Halmahera earthquake mw=7.2 to mount Soputan and Gamalama volcanic activities](#)
G H D Sinaga, M Zarlis, M Sitepu et al.



The Electrochemical Society
Advancing solid state & electrochemical science & technology

242nd ECS Meeting
Oct 9 – 13, 2022 • Atlanta, GA, US
Presenting more than 2,400 technical abstracts in 50 symposia


ECS Plenary Lecture featuring M. Stanley Whittingham,
Binghamton University
Nobel Laureate – 2019 Nobel Prize in Chemistry

 Register now!



Characteristics of Halmahera Eddy and its relation to sea surface temperature, chlorophyll-a, and thermocline layer

Muhammad Firdaus Ramadhan^{1*}, Denny Nugroho Sugianto^{1,2}, Anindya Wirasatriya^{1,2}, Heryoso Setiyono¹, Kunarso^{1,2}, Lilik Maslukah^{1,2}

¹Department of Oceanography, Faculty of Fisheries and Marine Science, Diponegoro University, Jl. Prof. Sudharto SH, Tembalang, Semarang, Indonesia.

²Center for Coastal Disaster Mitigation and Rehabilitation Studies, Universitas Diponegoro, Semarang Indonesia.

*Corresponding author: firdausram16@gmail.com

Abstract. Western equatorial Pacific is a confluence region of the water mass from the northern hemisphere and the southern hemisphere. One of the interesting phenomena in this region is Halmahera Eddy. The purpose of this research is to investigate the seasonal variability of the Halmahera Eddy on several depths and its relation to the primary productivity using sea surface temperature and chlorophyll-a parameters. In addition, this research also investigates the influence of the surface currents of the Halmahera Eddy to the thermocline layer. The results show that the Halmahera Eddy on the surface is affected by several currents in the waters of the Western Pacific Ocean and the monsoon system that is strengthened in the East Monsoon-Transition II (June-October), while weakened by the end of Transition II-West monsoon (November-February), Current Depth of Halmahera Eddy pattern strengthening, weakening, shifting every seasons and the currents weaker along with increasing depth. The primary productivity is identified by chlorophyll-a (0.1-0.15 mg/m³) and warm pool (28-31°C) in Halmahera sea. Halmahera Eddy also can suppress the thermocline layer.

1. Introduction

Halmahera Eddy is one of the interesting phenomenon located in the Western Pacific and close to the equator. Eddy currents have spatial scales ranging from tens to hundreds of kilometers and temporal scales ranging from weekly to monthly [1]. There are two kinds of eddy circulation namely cyclonic (clockwise in the southern hemisphere) and anticyclonic (anticlockwise in the southern hemisphere). Halmahera Eddy is one of the most interesting eddy flows since it relates to the continuous circulation of water mass, and is related to the primary productivity of the waters [2]. The surface structure identification of Halmahera Eddy using a surface chlorophyll image showing the emergence of chlorophyll-a hues formed by circulating flow. The high-surface chlorophyll-a concentration occurs at the edges of the vortex forming a high surface chlorophyll-a belt, while the inside of the concentration of chlorophyll-A is a lower [3].



Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

The surface characteristic of Halmahera Eddy has been studied by many researchers [e.g.,1,3]. This research was conducted to describe Halmahera Eddy not only for a surface layer but also for subsurface layers. We focus our study area at coordinates 8°N-2°S and 125°E-138°E. Furthermore, the relationship among Halmahera Eddy, the thermocline layer, sea surface temperature and chlorophyll-a is also investigated in this study which then can be used to support the utilization of marine and fisheries potential resources as they relate to primary productivity in these areas.

2. Methodology

The main dataset used in this study were current sea data, Mixed Layer Data (MLD) and vertical temperature data obtained from the Copernicus Marine Environment Monitoring Service (CMEMS) with a spatial resolution of 0.25°× 0.25° while sea surface temperature and chlorophyll-a data from Ocean Color with spatial resolution of 4 km with Net Common Data File (NetCDF) format, the data compiled monthly climatology from 2011-2015. Before conducting monthly climatology, the data are made monthly averages. Here is the formula for monthly climatology [4]:

$$X(x, y) = \frac{1}{n} \sum_{i=0}^n xi(x, y, t) \text{-----(1)}$$

Where X (x, y) is the monthly average value and the monthly climatology at position (x, y), where xi (x, y, t) is the i value of data (x, y) and time t. n is there the amount of data in a month and the number of n monthly climatological data calculations, in this study 2011-2015 = 5 data [4]. Data processing of sea currents, sea surface temperature and Chlorophyll-a using programming software, while mixed layer depth data and vertical temperatures using ODV.

The Halmahera Eddy is identified visually using the current vector that forms circular shape and separates from the main current. Meanwhile, to identify the relationship between Halmahera Eddy with sea surface temperature and chlorophyll-a by comparing the value of the results of the distribution of sea surface temperature and chlorophyll-a concentration with the surface current vector in the Halmahera Eddy vortex in each season, so the sea surface temperature will be known and chlorophyll-a concentration in the study area when eddy currents occur. To find out the effect of Halmahera Eddy on the thermocline layer, the analysis was carried out by comparing the Halmahera Eddy with vertical temperature data and Mixed Layer Depth (MLD) data that represented as the upper boundary of the thermocline layer. Then identify the upper and lower boundary layer of the thermocline when the eddy current forms on the surface.

3. Results and Discussion

3.1. Seasonal variability Halmahera Eddy on surface

The formation of Halmahera Eddy on the surface is influenced by several currents in the study area namely North Equatorial Counter Current (NECC), South Equatorial Current (SEC), New Guinea Coastal under Current (NGCC), Mindanao Current (MC) [5]. The Mindanao Current has a major role in shaping and strengthening the movement of the NECC current, the Mindanao current moving from the north then turning east to form the NECC, while the NGCC current has a role in forming Halmahera Eddy which moves along the northern coast of Papua. The current meeting had a large role in the formation of Halmahera Eddy. On Halmahera Eddy surface, at the center point of Halmahera Eddy has a current speed of 0.1-0.2 m / sec, while at the edge the speed reaches 0.4-1.5 m / sec. Halmahera Eddy strongest occurred in June and July with a diameter of about 770 km from the eddy west longitude to the east longitude, while the smallest diameter of about 165 km that occurred in April. Halmahera Eddy is the type of mesoscale eddy with a diameter between 100-1000 km [2]. The size of the diameter

depends on the velocity between the NECC and NGCC currents that form Halmahera Eddy. The weakening and strengthening factor is due to the NECC and NGCC currents that are thought to be influenced by the Monsoon system, the strengthening of the Halmahera Eddy that occurred during the East-Transition II (June-October) because the NGCC currents were driven by winds that move from southeast to southwest, so the NGCC currents that formed Halmahera Eddy became stronger. Instead, at the end of the Transition II-West Monsoon (November-February) Halmahera Eddy weakens and disappears, the wind moving from the north to the southeast, thus allegedly helping push NGCC flow in the opposite direction with the formation of Halmahera Eddy. East Monsoon (April-October) Halmahera Eddy strengthened because the NGCC currents tended to be stronger so that cause the strengthening of Halmahera Eddy. Meanwhile, when the West Monsoon (October-April) Halmahera Eddy weakened in the Indonesian monsoon system, along with the change in direction of the NGCC [3].

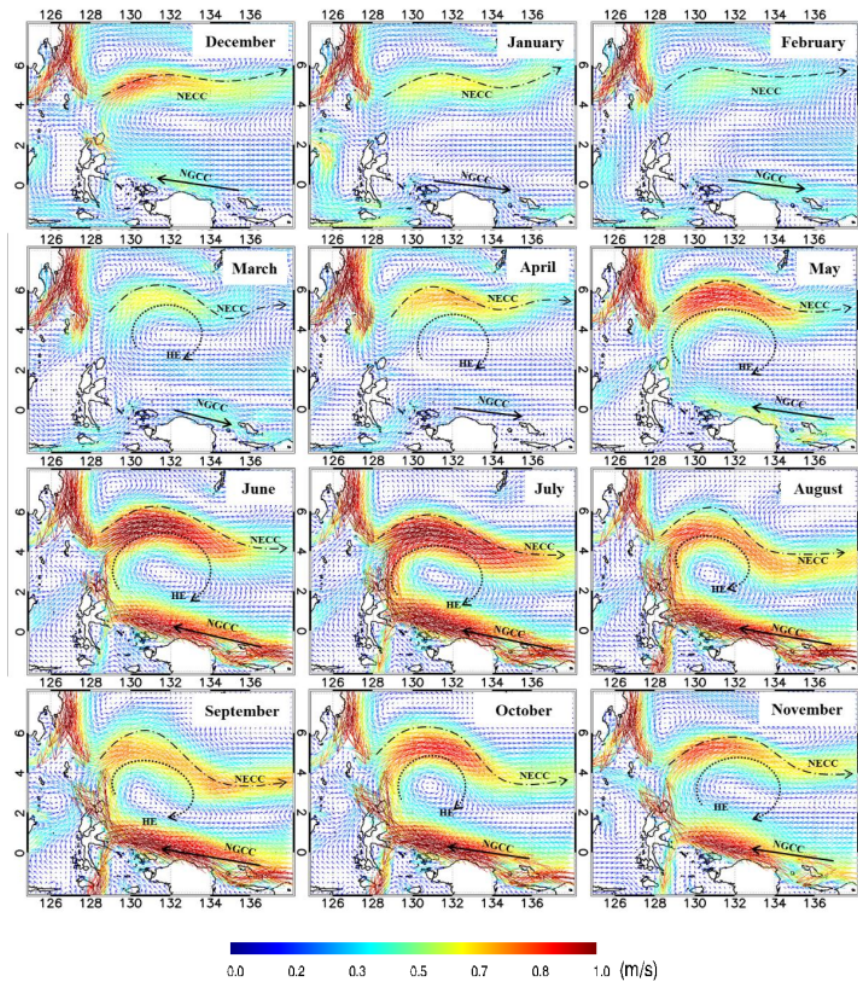


Fig. 1. Halmahera Eddy Surface Current in East Monsoon- Transition II

3.2. The relation between Halmahera Eddy and SST

Based on Figure 2 sea surface temperature in the Halmahera Eddy vortex is high in the range 28-31°C, the distribution of sea surface temperature in the study area is also not too variable. Halmahera Eddy is a current that rotates clockwise (anticyclonic eddy) causes the phenomenon of downwelling, but the effect of downwelling cannot be identified because the waters outside Halmahera Eddy also have high temperatures. Therefore, Halmahera Eddy may not have a significant influence on changes in sea surface temperature values in the vortex, despite the downwelling phenomenon. The area between the waters of Mindanao-Papua New Guinea is part of a warm pool area that has been known as the hottest sea surface temperature in the world (> 29°C) [6]. Sea surface temperatures are high in the Halmahera Sea and its surroundings due to a phenomenon warm pool cause the region including the waters of the fertile region known as the warm Pool supplying the largest of production of tuna world (> 1.5 million tonnes per year) in the Pacific Ocean, or about 40% of the total catch world tuna is in this water region [7]. Besides, the meeting of water masses from the two southern and northern hemispheres forms an oceanfront where the NECC water mass source is formed so that it has high pelagic fish production because it is a warm pool area and has a high concentration of chlorophyll-a [8]. Furthermore, the Maluku Sea and the Halmahera Sea may also influence the primary productivity in the Halmahera Eddy region since the Northern part of the Maluku Sea and the Halmahera Sea have high chlorophyll-a concentration during East monsoon [9,10].

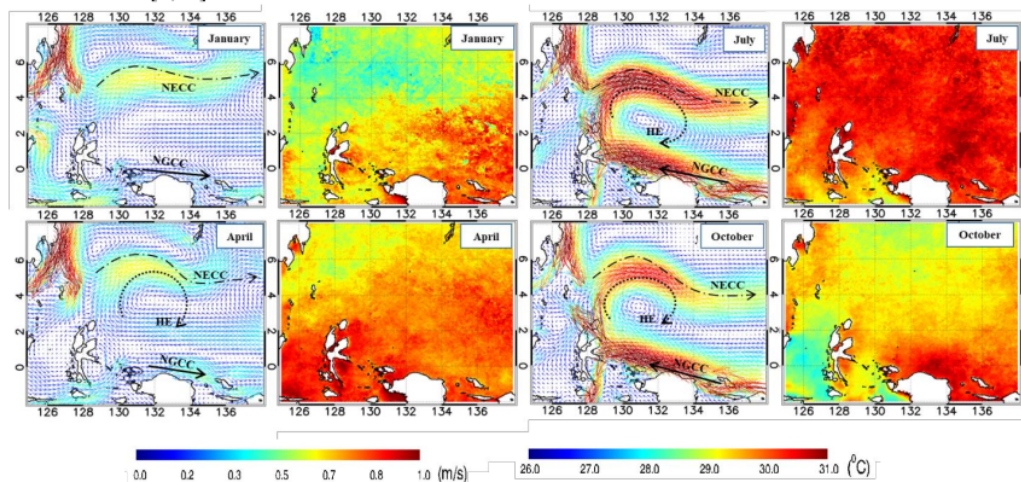


Fig. 2. Surface Halmahera Eddy Current and SST

3.3. Relation between Halmahera Eddy and chlorophyll-a

Different with SST the relationship between Halmahera Eddy and chlorophyll-a is clearly shown in Fig.3. In July and October when Halmahera Eddy is strong, chlorophyll-a concentration within the eddy is also high. In contrast, in January and April when Halmahera Eddy is weak, chlorophyll-a concentration is also low. The chlorophyll-a concentration in the Halmahera Eddy vortex is in the range 0.1-0.15 mg/ m³. The chlorophyll-a concentration in the Halmahera Eddy vortex is higher than that in the north. This higher concentration is caused by several factors. One of the causes of high chlorophyll-a concentrations in the Halmahera Sea and its surroundings which is a convergence zone,

characterized by the presence of micronekton and organic matter. Some nutrients and phytoplankton originating from the divergent zone in the Central Pacific will be carried by the mass of water to the area of convergence to a distance of 1800-2500 km [11].

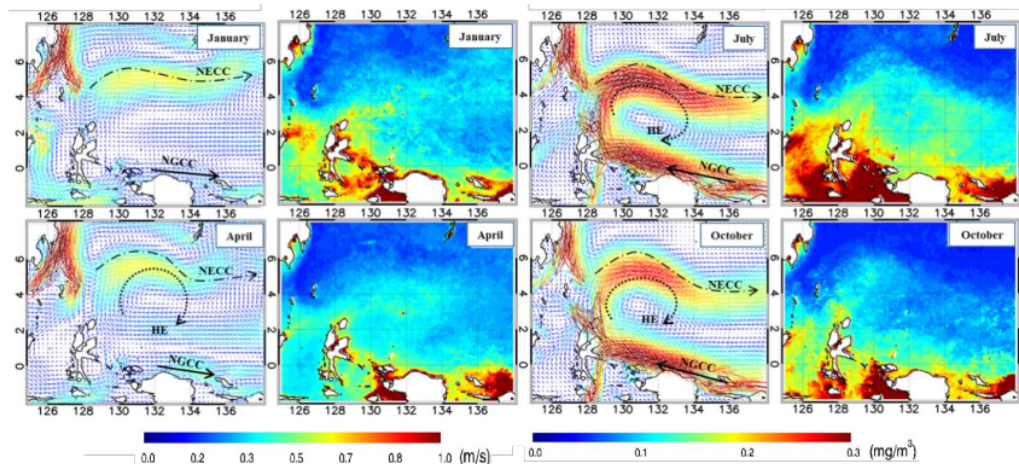


Fig. 3. Surface Halmahera Eddy Current and Chlorophyll-a

Chlorophyll-a is carried with the mass of water by NGCC currents from the Western Pacific so that nutrients and phytoplankton gather in the Halmahera Eddy vortex. Also, higher chlorophyll-a concentrations of 0.2-0.3 mg / m³ originating from the north coast of Papua were also carried by NGCC currents, then gathered at the Halmahera Eddy vortex. The high chlorophyll-a concentration within Halmahera Eddy may also contributed from the influence of the Maluku Sea and Halmahera Sea especially when the intensive upwelling period occurs during summer monsoon [4]. Also, the high chlorophyll-a concentration in the Halmahera Eddy vortex is also caused by the interaction of internal tide waves with the sea ridge (sill) in the Halmahera Strait and the influence of inputs from large rivers such as the Sepik River and the Membramo River carrying several large nutrients to the Halmahera Sea. The conditions along the northern coast of Papua to Halmahera, which is the waters of the western edge of the equator of the western Pacific directly adjacent to the territorial waters known as the world's coral growth triangle which is the waters environment with the highest primary productivity [3]. These waters include large coral reef ecosystems along the northern coast of Papua, Raja Ampat, Halmahera to Morotai Islands.

3.4. The effect of Halmahera Eddy on thermocline layer

Halmahera Eddy is thought to influence the depth of the thermocline layer, causing the value of the temperature gradient in the thermocline layer is different in each month. The temperature gradient value in the thermocline layer has a value between 0.05-0.09 °C/m. The thermocline layer is defined as a depth or position where the temperature gradient is greater than or equal to 0.05 °C / m [12]. Based on the vertical profile, the temperature data above obtained the upper and lower boundary of the thermocline layer using vertical temperatures data (Table 1).

8
 Table 1. Upper and Lower Boundary Thermocline Layer (m)

Month	Upper Boundary Thermocline Layer (m)	Lower Boundary Thermocline Layer (m)
January	22	370
February	22	370
March	16	400
April	16	400
May	19	400
June	26	370
July	47	370
August	53	370
September	47	370
October	41	370
November	22	400
December	16	370

The depth of the upper thermocline layer in the west Monsoon from December to February 16 m, 22 m, 22 m, respectively. The depth of the thermocline layer is thought to be the influence of high rainfall during the west Monsoon because in the west Monsoon Halmahera Eddy has not yet formed. High rainfall affects the thickness of the homogeneous layer (Mixed Layer Depth), causing the homogeneous layer to get thicker, and push the upper boundary of the thermocline layer deeper. The depth of the upper boundary of the thermocline layer in the transition I in March and April is at a depth of 16 m. In this condition, Halmahera Eddy has not been a big effect because the eddy formed not too big, so do not push too deep the thermocline layer. Whereas in May, the influence of Halmahera Eddy strengthened pushing the upper boundary of the thermocline layer deeper at a depth of 19 m. Entering the East Monsoon, the influence of Halmahera Eddy on the depth of the upper limit of the thermocline layer is very large, because in the East Monsoon Halmahera Eddy has a large diameter and high current velocity. The depth of the thermocline upper limit is pushed to deeper depths from June to August, respectively 26 m, 47 m, 53 m. The thermocline layer is influenced by Halmahera Eddy, which direction of rotation is clockwise so that it will push the thermocline layer deeper [13]. Halmahera Eddy is an eddy that can generate the phenomenon of downwelling so that bringing the mass of water down to the bottom causes the thermocline layer to go down. Depth on the upper boundary of the thermocline layer in transition II, the upper limit of the thermocline layer is still affected by Halmahera Eddy by showing increasingly shallow depth shifts in September, October, November, respectively 47 m, 41 m, and 22 m, in November there was a significant shift in the shallower depth due to the weakening of Halmahera Eddy. Halmahera Eddy does not affect the lower boundary of the thermocline layer on the strong and weak Halmahera Eddy, because the lower boundary of the thermocline remains at a depth of 370 m or 400 m. At the lower boundary of the thermocline, there is no significant change in temperature at the depth below (Deep Layer), underneath the thermocline layer is a cold inner layer [14]. In this layer, temperature changes occur very small and relatively constant. Temperature changes start from 11.83°C to 4.116°C. In general, this layer is affected by small currents, so conditions are very stable and temperatures tend to be constant. The same thing is shown in Table 2. from the horizontal distribution data (Mixed Layer Depth).

Table 2. Upper Boundary Thermocline Layer

Month	Upper Boundary Thermocline Layer
January	29
February	25
March	16
April	14
May	18
June	24
July	36
August	44
September	31
October	30
November	12

Table 2 shows in December the thermocline upper boundary at a depth of about 14 m. In January and February, the distribution of the upper limit of the thermocline in the waters drops to a deeper depth of around 29 m and 25 m, this is allegedly due to the influence of high rainfall during the west monsoon, which in the west monsoon has not been influenced by Halmahera Eddy because it has not yet formed. High rainfall affects the thickness of the homogeneous layer (Mixed Layer Depth), thus causing the homogeneous layer to get thicker and push the upper limit of the thermocline layer deeper. Entering the transition I show that in this season, in March it was suspected that the West Monsoon was still affected by the high rainfall conditions so that the upper limit of the thermocline layer was around 14 m. In April the influence of Halmahera Eddy was not large because the eddy that was formed was not too large, so it could not push the thermocline layer too deep with the depth of the thermocline upper boundary of about 13 m. Whereas in May the influence of Halmahera Eddy began to be seen by pushing the upper limit of the thermocline layer deeper than April by around 18 m. The biggest influence of Halmahera Eddy in the East monsoon shows that Halmahera Eddy has a large diameter and is getting stronger so that the upper boundary layer of the thermocline is pushed deeper in June-August respectively around 24 m, 36 m and 44 m. The thermocline layer is influenced by Halmahera Eddy whose direction of rotation is clockwise and will push the thermocline layer deeper. Halmahera Eddy is an eddy that can generate downwelling phenomena so that bringing the mass of water down to the bottom causes the thermocline layer to go down [13]. In September-November began to weaken than the previous season. This situation caused a shift in the upper boundary of the thermocline layer to a shallower depth of 31 m, 30 m and in November, indicating an increase in the upper boundary of the thermocline layer to a depth of 12 m.

3.5. Halmahera Eddy on several depth

Halmahera Eddy at a depth of 11.7 m represents the Mixed Layer, 100-300 m represents the thermocline layer and 400-500 m represents the inner layer. and the distribution of SST values in each season is represented by January for the West Monsoon, April for the Transition I, July for the East Monsoon, and October for the Transition II from 2011-2015.

3.5.1. West Monsoon (January)

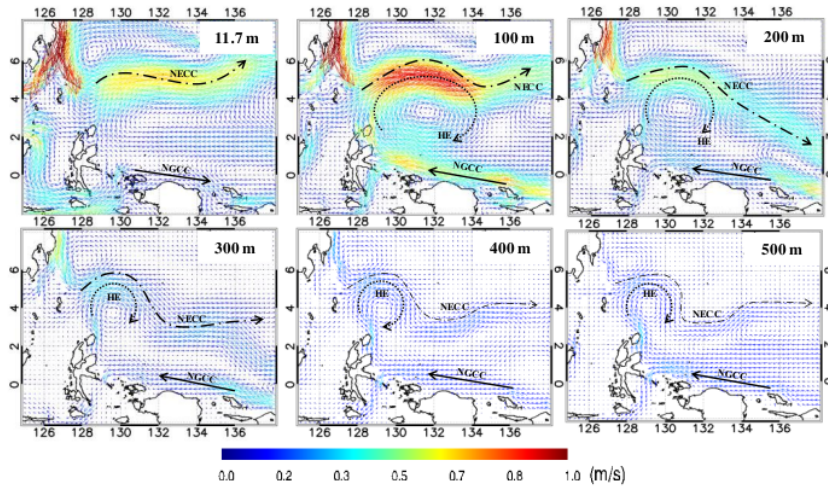


Fig.4 Halmahera Eddy in West Monsoon

Based on (Fig.4) in the West Monsoon at a depth of 11.7 m, it appears that Halmahera Eddy's vortex has not yet formed, this is because the mixed layer is affected by the monsoon system which is indeed weakening during the West Monsoon. At a depth of 100 m, the Halmahera Eddy vortex is very strong, in contrast to the depth of 11.7 m at a depth of 100 m the monsoon system has no effect anymore, at this depth the NECC and NGCUC currents move quickly to form the Halmahera Eddy vortex. At a depth of 200 m Halmahera Eddy's vortex weakened, because the NGCUC current weakened significantly. At a depth of 300-500 m the Halmahera Eddy vortex shifts more towards the north of Halmahera Island and grows weaker as the depth increases, the diameter of the Halmahera Eddy vortex decreases because the NECC and NGCUC currents are weakening, especially when it has penetrated the inner layer of depth 400 and 500 m.

3.5.2. Transition I (April)

Based on (Fig.5) in Transition I Halmahera Eddy at 11.7 m depth began to form this is due to NECC currents starting to strengthen, and SEC currents that move from the Pacific Ocean turn north and join the strong NECC currents to form the Halmahera Eddy. At a depth of 100 m, the NGUCC and SEC currents merge to turn north and join the NECC current which is so strong that it forms the Halmahera Eddy vortex, in Transition I the Halmahera Eddy current pattern at a depth of 100 m shows no difference with the West Monsoon. At a depth of 200 m Halmahera Eddy weakened due to weakening NECC and NGCUC currents, but the pattern was still the same as a depth of 100 m. At a depth of 200-500 m, Halmahera Eddy moves north of Halmahera Island and is getting weaker with smaller diameter, just like during the West Monsoon.

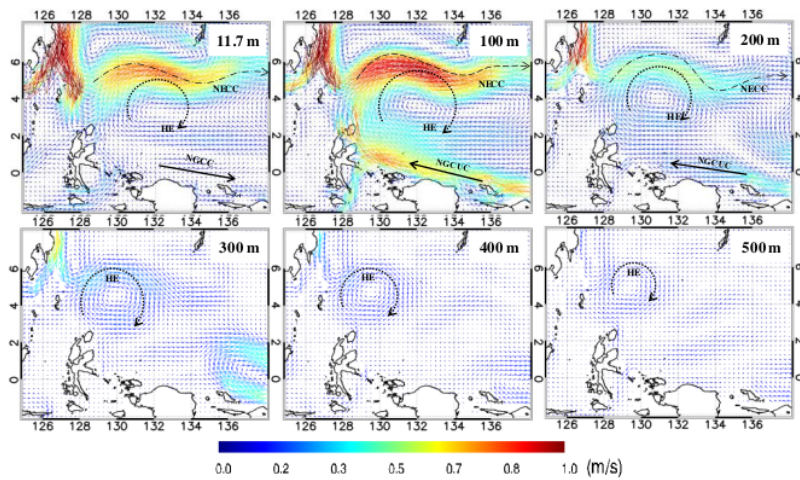


Fig.5 Halmahera Eddy in Transition I

3.5.3. East Monsoon (July)

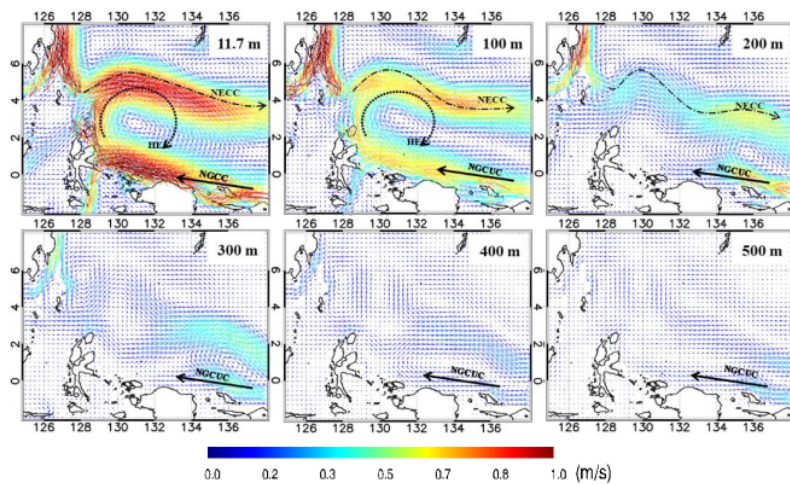


Fig. 6 Halmahera Eddy in East Monsoon

Based on (Fig.6) in the East Monsoon at a depth of 11.7 m, the NECC and NGCC currents are moving very strongly, so that the Halmahera Eddy vortex formed becomes strong and large. At a depth of 100 m the Halmahera Eddy is getting weaker, this weakening is due to the weakening of the NECC and NGCC currents and also the Halmahera Eddy is depressed due to the presence of new eddy currents from above the NECC currents that are seen that it is suspected that Palau Eddy is shifting towards the south thereby suppressing the NECC currents causes a narrowing of the distance between the NECC current and the NGCC current. At a depth of 200 m, the NECC and NGCC currents were significantly weakened, and the NGCC currents deflected to the north were very weak, so as not to form the Halmahera Eddy vortex. At a depth of 200 m, the emergence of eddy in the north of the island

of Papua is New Geanue Eddy (NGE). Halmahera Eddy at a depth of 200-500 m in the Eastern Season disappeared, with the weakening of the NECC current and the NGCUC current.

3.5.4. Transition II (October)

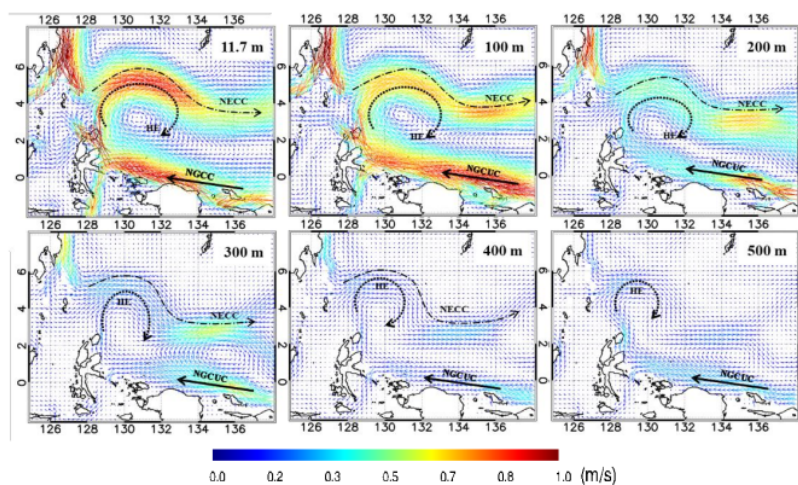


Fig. 7 Halmahera Eddy in Transition II

Based on (Fig.7) in Transition II Halmahera Eddy at a depth of 11.7-200 m is almost the same, but there was a weakening due to the weakening of the NECC and NGCC or NGCUC currents. Also, at a depth of 200 m, there was a narrowing of the distance between NECC and NGCUC because the NECC current was suppressed by Palau Eddy's shift to the south. In Transition II at a depth of 300-500 m, Halmahera Eddy began to form again even though the vortex was very weak. Based on these results, at a depth of 11.7 m which is in a layer mixed with Halmahera Eddy pattern is still the same as on the surface, the formation of Halmahera Eddy at this depth is influenced by NECC, SEC, NGCC currents, Mindanao Current, and influenced by the monsoon system which strengthens from the East Season - Transition II (June-October), while weakening from the end of Transition II - West Season (November-February). At a depth of 100-300 m which is in the thermocline layer, the formation of Halmahera Eddy is influenced by NECC and NGCUC currents which naturally weaken as they increase, but are still visible to a depth of 300 m although not strong. At depths of 400-500 which represent layers in the formation of Halmahera Eddy is very weak, this is because the NECC and NGCUC currents that form the Halmahera Eddy are very weak at speeds of less than 0.3 m / s, the weakening of the NECC is presumably due to the weak supply from Mindanao Current at 400- 500 m.

4. Conclusion

The formation of Halmahera Eddy is influenced by the North Equatorial Counter Current (NECC), the South Equatorial Current (SEC), the New Guinea Coastal Current (NGCC), the New Guinea Coastal Under Current (NGCUC), and the Mindanao Current (MC). In addition, the monsoon system is also influenced by the strength and weaknesses of Halmahera Eddy. Halmahera Eddy on the surface strengthened from the East-Transition II Season (June-October) and weakened from the end of the Transitional II-West Season (November-February). Halmahera Eddy whose rotation clockwise causes the phenomenon of downwelling to push the thermocline layer down deeper. Productivity in the Halmahera Sea and surrounding areas is because the waters include warm pool areas with sea surface

temperature values ranging from 28-31°C and the influence of Halmahera Eddy which causes chlorophyll-a to gather in the vortex with concentration values ranging from 0.1-0.15 mg/m³. The phenomenon of downwelling due to Halmahera Eddy also causes the fertile waters at some depth.

Acknowledgments

This research is funded by Director General of Research and Development Strengthening, Ministry of Research Technology and Higher Education Under The Scheme of Fundamental Research, Contract Number 257-16/UN7.P4.3/PP/2019

References

- [1] Harsono G 2014 Kajian Arus Pusar Halmahera Menggunakan Data Satelit Multisensor Dan Hidrografi Serta Kaitannya Dengan Produktivitas Cakalang (*Katsuwonus pelamis*) [PhD Thesis] Sekolah Pascasarjana, Insitut Pertanian Bogor, Bogor, 41-81
- [2] Rhines P B 2001 *Encyclopedia of Ocean Sciences* **3** 1717- 1730
- [3] Harsono G , Atmadipoera A S , Syamsudin F , Manurung D and Mulyono S B 2014 *Asian Journal of Scientific Research* **7(4)** 571-580
- [4] Wirasatriya A , Setiawan R Y , and Subardjo P 2017 *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing* **10(12)** 5513 - 5518
- [5] Wang F , Li Y , and Wang J 2016 *Journal of Physical Oceanography* **46(12)** 3639-3660
- [6] Messie M dan MH Radenac 2006 *Seasonal Variability of the Surface Chlorophyll in the western Tropical Pacific from Sea WiFS data* Deep-Sea Res I , **53**: 1581-1600
- [7] Lehodey P 2001 *Prog Oceanogr* **49** 439-468
- [8] Kashino Y , Ueki I , Kuroda Y , and Purwandani, A 2007 *J Oceanogr* **63** 545-559
- [9] Wirasatriya A , Sugianto D N , Helmi M , Setiawan R Y and Koch M 2019 *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing* **12(6)** 1763-1770
- [10] Setiawan R Y , Wirasatriya A , Hernawan U , Leung S , Iskandar I 2020 *Int J Rem Sens* **41(1)** 284-299
- [11] Lehodey P , Bertignac M , Hampton J , Lewis A , and Picaut J 1997 *Nature* **389** 715-718
- [12] Bureau of technical supervision of the P R of China 1992 The Specification for Oceanographic Survey Oceanographic Survey Data Processing (GB/T 12763 7-91) Standards press of China P 68-70
- [13] Hutabarat M F , Purba N P , Astuty S , Syamsuddin M L , and Kuswardani A R T D 2018 *Jurnal Perikanan dan Kelautan* **9(1)** 9-21
- [14] Sidabutar H , Cahayani, Rifai A , and Indrayanti E 2014 *Jurnal Oseanografi* **3(2)** 135-141

Characteristics of Halmahera Eddy and its relation to sea surface temperature, Chlorophyll-a, and Thermocline layer

ORIGINALITY REPORT

6%

SIMILARITY INDEX

%

INTERNET SOURCES

6%

PUBLICATIONS

%

STUDENT PAPERS

PRIMARY SOURCES

- 1 Max Rudolf Muskananfola, Jumsar, Anindya Wirasatriya. "Spatio-temporal distribution of chlorophyll-a concentration, sea surface temperature and wind speed using aqua-modis satellite imagery over the Savu Sea, Indonesia", *Remote Sensing Applications: Society and Environment*, 2021
Publication 1%

- 2 M. D. Kravchishina, A. A. Klyuvitkin, L. A. Pautova, N. V. Politova, A. Yu. Lein. "Stable Isotopic Composition of Particulate Organic Carbon in the Caspian Sea", *Oceanology*, 2018
Publication 1%

- 3 Franz Philip Tuchen, Joke F. Lübbecke, Peter Brandt, Yao Fu. "Observed Transport Variability of the Atlantic Subtropical Cells and Their Connection to Tropical Sea Surface Temperature Variability", *Journal of Geophysical Research: Oceans*, 2020
Publication 1%

4

Z. D. Zhao, J. R. Wu, E. C. Shang. "How the thermocline affects the value of the waveguide invariant in a shallow-water waveguide", *The Journal of the Acoustical Society of America*, 2015

Publication

1 %

5

Zhuo Chen, Jun Sun, Ting Gu, Guicheng Zhang, Yuqiu Wei. "Nutrient ratios driven by vertical stratification regulate phytoplankton community structure in the oligotrophic western Pacific Ocean", *Ocean Science*, 2021

Publication

<1 %

6

Braddock K. Linsley, Henry C. Wu, Tim Rixen, Christopher D. Charles, Arnold L. Gordon, Michael D. Moore. "SPCZ zonal events and downstream influence on surface ocean conditions in the Indonesian Throughflow region", *Geophysical Research Letters*, 2017

Publication

<1 %

7

Febryanto Simanjuntak, Tang-Huang Lin. "Monsoon Effects on Chlorophyll-a, Sea Surface Temperature, and Ekman Dynamics Variability along the Southern Coast of Lesser Sunda Islands and Its Relation to ENSO and IOD Based on Satellite Observations", *Remote Sensing*, 2022

Publication

<1 %

8

Chong Wang, Minghao Zhao, Kai Wang, Feng-Lin Wei, Yu Jiang. "Analysis of Three-Dimensional Thermocline Based on Argo Data", 2018 OCEANS - MTS/IEEE Kobe Techno-Oceans (OTO), 2018

Publication

<1 %

9

A. R. Piola, N. M. Avellaneda, R. A. Guerrero, F. P. Jardón, E. D. Palma, S. I. Romero. "Malvinas-slope water intrusions on the northern Patagonia continental shelf", Copernicus GmbH, 2009

Publication

<1 %

10

Anindya Wirasatriya, Denny Nugroho Sugianto, Muhammad Helmi, Riza Yuliratno Setiawan, Magaly Koch. "Distinct Characteristics of SST Variabilities in the Sulawesi Sea and the Northern Part of the Maluku Sea During the Southeast Monsoon", IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 2019

Publication

<1 %

11

R. Roussel-Dupré. "Physical Processes Related to Discharges in Planetary Atmospheres", Space Sciences Series of ISSI, 2008

Publication

<1 %

12

Yunyan Chen, Xiaoxia Sun, Mingliang Zhun. "Net-phytoplankton communities in the Western Boundary Currents and their

<1 %

environmental correlations", Journal of
Oceanology and Limnology, 2017

Publication

13

Harada, N.. "Alkenones and particulate fluxes
in sediment traps from the central equatorial
Pacific", Deep-Sea Research Part I, 200103

Publication

<1 %

Exclude quotes On

Exclude matches Off

Exclude bibliography On