Air-Sea interaction in the Tropical Pacific Ocean during 2018 as revealed by multi-satellite data

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Abstract. The air-sea interaction in the tropical pacific ocean is a critical to influence climate change around Pacific Ocean and whole of the world. According to that matter, this research is supposed to explain the variations of climate parameters in Pacific Ocean during 2017/2018 as La Niña tendency with using several satellite data which consist of: sea surface temperature (SST), sea level pressure (SLP), outgoing longwave radiation (OLR), wind and precipitation with length of time from 2005 until 2018 as compared with climate activity in 2010/2011 La Niña phenomenon. The 3.4 nino index showed there is short periods (less than six month) negative values deviation in 2017/2018 or cannot be claimed as La Niña phenomenon. Consistent with 3.4 nino index, the air-sea interaction in 2017/2018 has showed normal condition since no significant anomaly activity in parameters used if compared with parameters activity in 2010/2011 La Niña phenomenon.

1. Introduction

The La Niña phenomenon which originated from Pacific Ocean have an important role play of climate changes in the world [1]. The Phenomenon of La Niña generally called as a counter of El Niño Phenomenon. The Named of El Niño and La Niña is come from Fisherman coastal Peru which observed warm and cool currents in Pacific Ocean [2]. The Phenomenon of El Niño is characterized by weakening trade winds along equatorial Pacific Ocean which followed by movement of warm pool (convective zone) to the middle toward Eastern Pacific Ocean [3]. In other hand, the La Niña Phenomenon is characterized by increasing trade winds in east region Pacific Ocean due to higher upwelling in eastern part of Pacific Ocean (Cold Tongue). The increasing trade winds can also drive a warm pool to the west (Indonesian Region), so that east Indonesian will experience high rainfall [4]. The El Niño and La Niña events are often repeated every 3 – 7 years [5].

There are two ways commonly used to detect ENSO (El Niño/La Niña) phenomenon. The first one is calculated the standard deviations of atmosphere pressure different of two regions, western and eastern Pacific Ocean as a Southern Oscilation Index (SOI) product, where positive (negative) values SOI represent La Niña (El Niño). Another way, ENSO can be detected by observation SST anomaly on Nino index region, Where the El Niño represented by warm SST as positive values and La Niña represented by cool SST as negative values.

According to that matter, this research is designed to analyze mechanism of climate activity in the early 2018 as La Niña tendency that used several parameters, such as: SST, SLP, OLR, wind and precipitation. Afterwards this research also compared the air-sea interaction process in early 2018 with super La Niña 2010/2011 phenomenon. This paper have four sections besides the first introduction.
2. Data And Methods

2.1. Data
This research was used monthly timescale of some parameters e.g., SST, SLP, Wind Stress, Potential Velocity, Omega Velocity, Zonal Wind Velocity, OLR and Total Precipitation from several source consist of: European Centre For Medium Range Weather Forecast (ECMWF), Tropflux, and National Centers for Environmental Prediction and National Center for Atmospheric Research (NCEP/NCAR), during 2005 until 2018. This research also used 3.4 Nino Index to estimate deviation activity for expected La Niña event.

2.2. Methods
To analyze the air-sea interaction process, the first step is averaging all parameters as a climatological values. Then calculating the anomaly as deviation condition that was done by subtracting climatological data from the monthly timescale.

On the record, all calculations and presents Figure of parameters have done by Ferrets derived by National Oceanic and Atmospheric Administration (NOAA).

3. Result and Discussion
According to 3.4 Nino Anomaly index (Fig. 3.1), the negative values showed in early 2018 is not a La Niña phenomenon due to short periods of the negative values showed (less than six month) in early 2018. On other hand, 2010/2011 showed the negative values with long periods that claimed as La Niña phenomenon. The peak of two event was occurred in Desember, January, February Season (DJF) (Fig 3.1), so we calculated the monthly activity events in this season as compared of two years deviation activity.

![Fig 3.1. Niño Anomaly Index from January 2010 – Augustus 2018 from; http://www.cpc.ncep.noaa.gov/data/indices/sstoi.indices](image_url)

3.1. Climatology Conditions of Tropical Pacific Ocean

In this section, we discussed about climatology of Tropical Pacific Ocean conditions with climatology calculation from 2005-2015 of each parameters. We also examined the monthly climatology consist of: Desember, January, Februari (DJF) as a rainy season in Indonesia.
Based on Fig. 3.2a, SST of Western Pacific Ocean is warmer than eastern Pacific with anomaly values reach 31.6°C. This condition affected by westward trade winds which generally transport the water mass to the west Pacific Ocean and then accumulated on the west side (downwelling area). The increasing of SST has followed by weakening SLP in Western Pacific Ocean where anomaly values are 1008 mb. These conditions would push ahead convection activity (Fig 3.2b) in the Western Pacific, so that the Western Pacific Ocean would experience more rainfall intensity if compared with rainfall intensity in Eastern Pacific Ocean (Fig 3.3b). These condition also characterized by low OLR in Western Tropical Pacific Ocean than Eastern Tropical Pacific Ocean (Fig 3.3a).
The upwelling activity due to strong westward trade winds in Eastern Pacific Ocean was also triggered subsidence activity around this area, this clearly seen by divergence zone in Eastern Pacific Ocean where convection activity was strongly occur in Western Pacific Ocean (Fig 3.2c).

![Fig 3.3. DJF climatology of a) Outgoing Longwave Radiation and b) Total Precipitation from 2005 – 2015.](image)

### 3.2. Anomaly Conditions of Tropical Pacific Ocean during 2017/2018 La Niña tendency compared with 2010/2011 La Niña Phenomenon.

In 2017/2018, It observed lower negative anomaly of SST in eastern side with values decrease to -2.2°C. However, 2010/2011 La Niña phenomenon obviously seen more higher negative anomaly SST which spread along equator Pacific Ocean. Consistent with that matter, the SLP in 2017/2018 has showed no significant decrease in Western Pacific Ocean. On other hand, strong negative anomaly due to higher upwelling activity in eastern side during 2010/2011 would drive strong westward trade winds to blow warmpool from Central Pacific Ocean to the west zone heading Indonesian region. These conditions was characterized by increasing SLP along equator and decreasing SLP in Indonesian region during 2010/2011 (Fig 3.4).

According to Fig 3.5, the wind divergence in 2017/2018 has showed lower activity in the middle Pacific ocean but there is higher convergence activity in Indonesia region when it compared with wind divergence in 2010/2011 La Niña. These conditions was revealed why in 2017/2018 has experienced higher rainfall activity than 2010/2011 (Fig 3.8). However, the walker circulation in 2017/2018 presented lower convective activity in the western side if compared with walker circulation activity in 2010/2011 (Fig 3.6).

Afterward the OLR activity in two comparison deviation events has not showed significant decreasing in Indonesian region, but showed significant increasing in the western Pacific Ocean during 2010/2011 (Fig. 3.4).
Fig 3.4. DJF anomaly of SST (shaded) with spatial grid 0.25°×0.25°, SLP (contour) with spatial grid 0.5°×0.5°, and Wind Stress (vector) with spatial grid 0.25°×0.25, during 2017/2018 (upside) and 2010/2011 (downside).

Fig 3.5. DJF anomaly of wind divergence with spatial grid 1.875°×1.875°, during 2017/2018 (upside) and 2010/2011 (downside)
Fig 3.6. DJF anomaly of walker circulation with spatial grid 2.5°× 2.5°, during 2017/2018 (upside) and 2010/2011 (downside).

Fig 3.7. Anomaly of OLR with spatial grid 1°× 1°, during 2017/2018 (upside) and 2010/2011 (downside).
Fig 3.8. DJF anomaly of total precipitation with spatial grid 0.25°× 0.25°, during 2017/2018 (upside) and 2010/2011 (downside).

4. Conclusion
The study of mechanism climate activity in the early 2018 as La Niña tendency compared with the air-sea interaction process in super La Niña 2010/2011 phenomenon has been done using multi-satellite data. Generally, the results of this study have been combinated to some conclusion consist of:

1. The air-sea interaction in 2017/2018 was showed normal conditions since there is no significant anomaly activity in parameters used.
2. This Study showed that all parameters used was showed relationship each other for generate La Niña Phenomenon 2010/2011.
3. The activity of La Niña 2010/2011 was increased rainfall activity in Indonesian Region.
4. The rainfall activity in 2017/2018 was higher than rainfall activity in 2010/2011 since more convergence zone in western side during 2017/2018.

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