

Inter-Annual Variability of the Indonesian Rainfall and Air-Sea Interaction over the Indian-Pacific Ocean Associated with Regime Shift

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The inter-annual and inter-decadal variability of the Indonesian rainfall are investigated in association with the interannual climate modes over Indian-Pacific Oceans and the inter-decadal modulation on inter-annual climate variability impact. Rainfall data of the Climate Research Unit (CRU) from 1901 to 2016 and the Global Precipitation Climatology Project (GPCP) from 1979 to 2016 for June –November (JJASON) are used. The empirical orthogonal function (EOF) is used to identify the dominant spatial and temporal variability patterns of rainfall and the standard and partial correlation techniques are used to compare and to quantify the linear relationship between two or more time-series datasets. Based on the first principle component (PC1) of both CRU and GPCP data, the results show that canonical El Niño Southern-Oscillation (canonical ENSO), ENSO Modoki, and Indian Ocean Dipole (IOD) are the major climate modes influencing the inter-annual variability of the Indonesian rainfall, and the Inter-decadal Pacific Oscillation (IPO) is the major decadal phenomenon which affects the decadal variability of Indonesian rainfall. All of the inter-annual climate modes and IPO have negative correlation with the Indonesian rainfall, but the spatial distributions of Indonesian rainfall change associated with each phenomenon are different. During 1970 to 2016, three phases of IPO have been identified which are strongly related to Indonesian rainfall with the correlation coefficient of -0.75. The three phases are a negative phase in 1970-1978, a positive phase in 1979-1997, and another negative phase in 1998-2015. Mostly, these climate modes occur simultaneously, and the impacts of them on rainfall are combined. The driest condition of rainfall occurs when El Niño coincides with positive IOD during positive IPO, and the wettest condition occurs when La Niña –La Niña Modoki coincides with negative IOD during negative IPO over the whole region of Indonesia. The IPO plays a role in modulating the impact of these inter-annual climate modes on their frequencies and magnitudes to Indonesian rainfall from 1970s until present. The responses of the Indonesian rainfall to each inter-annual climate mode modulated by IPO are different as based on their time series correlation coefficient. The negative correlation between canonical ENSO and Indonesian rainfall weakens during negative IPO from early 2000s and intensifies during positive IPO. On the other hand, the negative correlation between ENSO Modoki and Indonesian rainfall and between IOD and Indonesian rainfall increases during negative phase of IPO from late 1990s, and the negative correlation between ENSO Modoki and Indonesian rainfall weakens during positive IPO. Recently, the frequency of ENSO Modoki and IOD and their impacts on Indonesian rainfall increase.

Keywords: Indonesian rainfall variability, El Niño Southern-Oscillation (ENSO), ENSO Modoki, Interannual Variability, Decadal Variability, Interdecadal Pacific Oscillation